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THE RACIAL GEOGRAPHY OF EUROPE.

A SOCIOLOGICAL STUDY.

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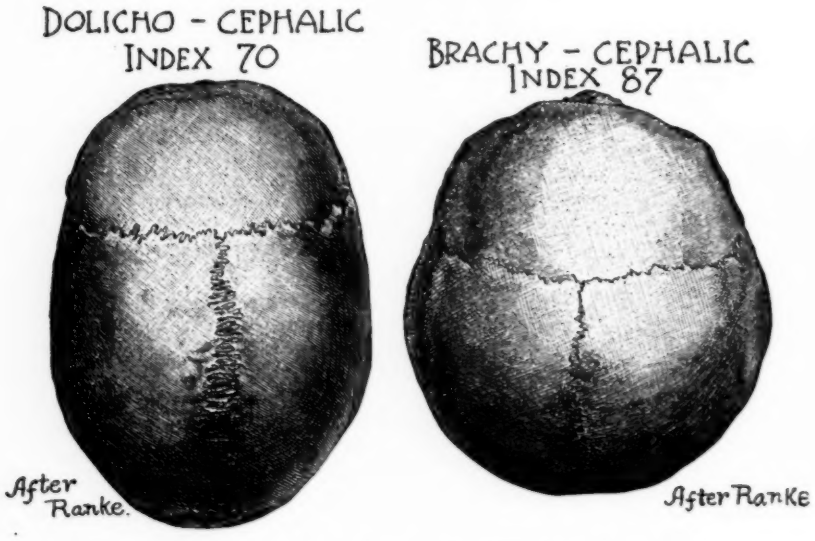
II.—THE SHAPE OF THE HEAD AS A RACIAL TRAIT.

THE shape of the human head—by which we mean the general proportions of length, breadth, and height, irrespective of the "bumps" of the phrenologist—is one of the best available tests of race known. Its value is, at the same time, but imperfectly appreciated beyond the inner circle of professional anthropology. Yet it is so simple a phenomenon, both in principle and in practical application, that it may readily be of use to the traveler and the not too superficial observer of men. To be sure, widespread and constant peculiarities of head form are less noticeable in America, because of the extreme variability of our population, compounded as it is of all the races of Europe; but in the Old World the observant traveler may with a little attention often detect the racial affinity of a people by this means.

The form of the head is for all racial purposes best measured by what is technically known as the cephalic index. This is simply the breadth of the head above the ears expressed in percentage of its length from forehead to back. Assuming that this length is 100, the width is expressed as a fraction of it. As the head becomes proportionately broader—that is, more fully rounded, viewed from the top down—this cephalic index increases. When it rises above 80, the head is called brachycephalic; when it falls below 75, the term dolichocephalic is applied to it. In-

dexes between 75 and 80 are characterized as mesocephalic. The two skulls in our illustrations, viewed from above, show how marked the differences in these proportions may be. In very rare instances the index may run in individuals as low as 62, and it has been observed as high as 103—that is to say, the head being broader than it is long. In our study, which is not of individuals, but of racial groups, the limits of variation are of course much



less. We shall seldom find heads in any considerable numbers exceeding the limits roughly indicated by the two crania in our illustrations.*

A factor which is of great assistance in the rapid identification of racial types is the correlation between the proportions of the head and the form of the face. In the majority of cases, particularly in Europe, a relatively broad head is accompanied by a rounded face, in which the breadth back of the cheek bones is

* Our data are drawn in the main not from the relative proportions of each type of head occurring within a given area, but from general averages made up by including all head forms alike. The more scieutific method would be to give the relative proportions of each type of head; but that is impossible with the present data. It is a comforting circumstance, however, that the results drawn from the average approximate closely enough to those obtained in the other way for all general purposes. Oftentimes, for lack of data, it is impossible to employ the more scientific method for detailed analysis. Anthropologists distinguish between the relative proportions of the head measured over all the soft tissues, giving the cephalic index, and those taken from the skull divested of all its fleshy parts, in which latter case the relation of length to breadth is expressed by the so-called cranial index. Experience has shown that the cephalic generally exceeds the cranial index by two units, more or less. In other words, the living head is relatively broader than the cranium by about three per cent. This would fix our extreme indices on the living head at about 72 and 89 for averages.

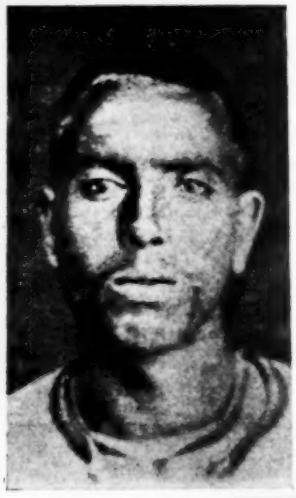
considerable as compared with the height from forehead to chin. Anthropologists make use of this relation to measure the so-called facial index; but a lack of uniformity in the mode of taking measurements has so far prevented extended observations fit for exact comparison. It is sufficient for our purposes to adopt the rule, long head, oval face; short head and round face. Our six types on the next page, arranged in an ascending series of cephalic indices from 65 to 94, make clearly manifest this relation between the head and face. In proportion as the heads become broader back of the temples, the face appears relatively shorter. The correspondence is not exact, as, for example, in the case of the brachycephalic type from Piedmont in Italy, where the face is rather long for the breadth of the head. This is probably a case of individual variation, perhaps due to racial intermixture. Only a few examples of widespread disharmonism, as it is called, between head and face are known. The Greenland Eskimos resemble the Lapp shown in our portrait in squareness of face, notwithstanding the fact, illustrated in the world map on page 582, that they are almost the longest-headed race known. In Europe, where disharmonism is very infrequent among the living populations, its prevalence in the prehistoric Cro-Magnon race, will afford us a means of identification of this type wherever it persists to-day. At times disharmonism arises in mixed types the product of a cross between a broad and a long headed race, wherein the one element contributes the head form while the other persists rather in the facial proportions. Such combinations are apt to occur among the Swiss, lying as they do at the ethnic cross-roads of the continent.

An important point to be noted in this connection is that this shape of the head seems to bear no direct relation to intellectual power or intelligence. Posterior development of the cranium does not imply a corresponding backwardness in culture. The broad-headed races of the earth may not as a whole be quite as deficient in civilization as some of the long heads, notably the Australians and Melanesians. On the other hand, the Chinese are conspicuously long-headed, surrounded by the barbarian brachycephalic Mongol hordes; and the Eskimos in many respects surpass the Indians in culture. Dozens of similar contrasts might be given. Europe offers the best refutation of the statement that the proportions of the head mean anything intellectually. The English, as our map of Europe will show, are distinctly long-headed. Measurements on the students at the Massachusetts Institute of Technology are fairly typical for the Anglo-Saxon peoples. Out of a total of 486 men, four were characterized at one extreme by an index below 70; the upper limit was marked by four men with an index of 87. The series of heads culminated at an index of 77,

BASEL, TEUTONIC TYPE.
Cephalic Index, 64.

tions of the head, therefore, we are measuring merely race, and not intelligence in any sense. How fortunate this circumstance is for our purposes will appear in due time.

Equally unimportant to the anthropologist is the absolute size of the head. It is grievous to contemplate the waste of energy when, during our civil war, over one million soldiers had their heads measured in respect of this absolute size, in view of the fact that to-day anthropologists deny any considerable significance attaching to this characteristic. Popularly, a large head with beetling eyebrows suffices to establish a man's intellectual credit; but, like all other credit, it is entirely dependent upon what lies on deposit elsewhere. Neither size nor weight of the brain seems to be of importance. The long, narrow heads, as a rule, have a smaller



BERBER, TUNIS.
Cephalic Index, 72.

possessed by 72 students. This figure is near the average for the British Isles; and likewise, it should be added, for Hottentots and the wild men of Borneo, as our world map shows. Comparisons have been instituted in parts of Europe between the professional and uncultured classes in the same community. The differences in head form are as apt to fall one way as another, depending upon the degree of racial purity which exists in each class.* In our study of the propor-

ISLAND OF ISCHIA, MIDDLE ITALY.
Cephalic Index, 83.

* Dr. Livi finds that in northern Italy the professional classes are longer-headed than the peasants; in the south the opposite rule prevails. The explanation is that in each case the upper classes are nearer a mean type for the country, as a result of greater mobility and ethnic intermixture. This topic is discussed by the author in Publications of the American Statistical Association, vol. v, p. 38 *seq.*

capacity than those in which the breadth is considerable; but the exceptions are so common that they disprove the rule. Among the earliest men whose remains have been found in Europe, there was no appreciable difference from the present living populations. In many cases these prehistoric men even surpassed the present population in the size of the head. The peasant and the philosopher can not be distinguished in this respect. For the same reason the striking difference between the sexes, the head of the man being considerably larger than that of the woman, means nothing more than avoirdupois; or rather it seems merely to be correlated with the taller stature and more massive frame of the human male.

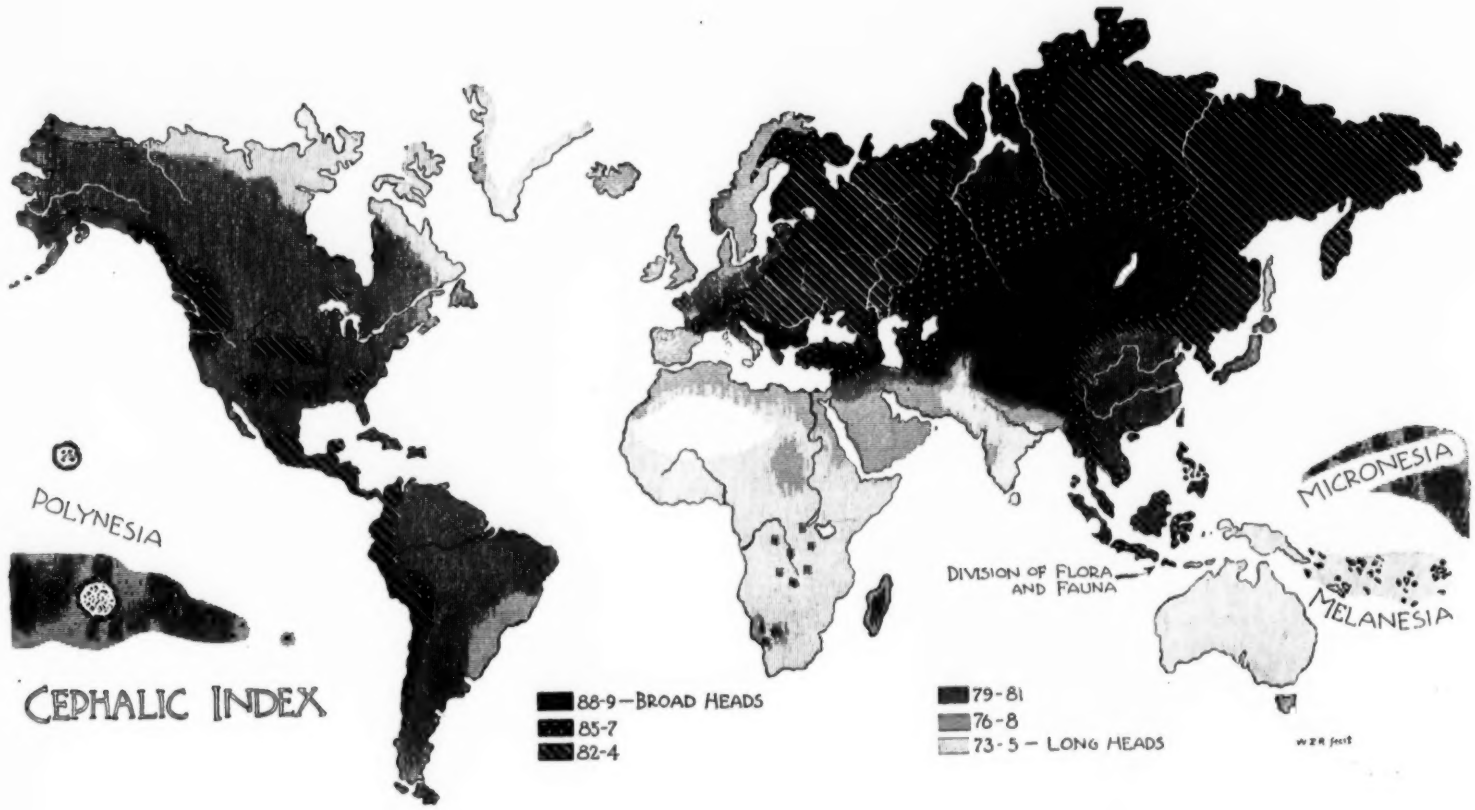
Turning to the world map* on the next page, showing the geographical distribution of the several types of head form which we have described, the first fact which impresses itself is of the violent contrasts in the eastern hemisphere between Europe-Asia, and the two southern continents Africa and Australia. Our two double portraits on pages 584 and 585 of the broad-headed, round-faced Asiatic and of the dolichocephalic, long-faced negro will serve as exam-

LAPP, SCANDINAVIA.
Cephalic Index, 94.

PIEDMONT, NORTHERN ITALY.
Cephalic Index, 91.

BAVARIAN TYROL.
Cephalic Index, 88±.

* This map is constructed primarily from data on living men, sufficient in amount to eliminate the effect of chance. Among a host of other authorities special mention should be made of Drs. Boas, on North America; Sören-Hansen and Bessels, on the Eskimos; von den Steinen, Ten Kate, and Martin, on South America; Collignon, Berenger-Feraud, Deniker, and Laloy, on Africa; Sommier and Mantegazza, on northern, Chantre and Ujfalvy, on western Asia; Risley, on India; Lubbers, Ten Kate,


POLYNESIA
MICRONESIA
MELANESIA
DIVISION OF FLORA AND FAUNA
CEPHALIC INDEX
88-9 — BROAD HEADS
85-7
82-4
79-81
76-8
73-5 — LONG HEADS
W.Z.R. feet

ples of these extremes. In profile the posterior development of the negro skull should be compared with the bullet-shaped head of the Asiatic. It will appear that differences in length are as remarkable as in the breadth. The line of division of head forms passes east and west just south of the great continental backbone extending from the Alps to the Himalayas. Thus the primitive natives of India, the black men of the hill tribes, who are quite distinct from the Hindu invaders, form part of this southern long-headed group. The three southern centers of long-headedness may once have been part of a single continent which occupied the basin of the Indian Ocean. From the peculiar geographical localization about this latter center of the lemurs, a species allied to the monkeys, together with certain other mammals, some naturalists have advocated the theory that such a continent once united Africa and Australia.* To this hypothetical land mass they have assigned the name Lemuria. It would be idle to discuss the theory in this place. Whether such a continent ever existed or not, the present geographical distribution of long-headedness points to a common derivation of the African, the Melanesian, and the Dravidian peoples of India. The phenomena of skin color and of hair only serve to strengthen the hypothesis.

The extremes in head form here presented between the north and the south of the eastern hemisphere constitute the mainstay of the theory that in these places we find the two primary elements of the human species. Other racial traits only help to confirm the deduction. The most sudden anthropo-geographical transition in the world is afforded by the Himalaya mountain ranges. Happily, we possess pretty detailed information for parts of this region, especially the Pamir. This "roof of the world" is of peculiar interest to us as the land to which Max Müller sought to trace the Aryan invaders of Europe by a study of the languages of that continent. It is clearly proved that this greatest mountain system in the world is at the same time the dividing line between the extreme types of mankind. It is really the

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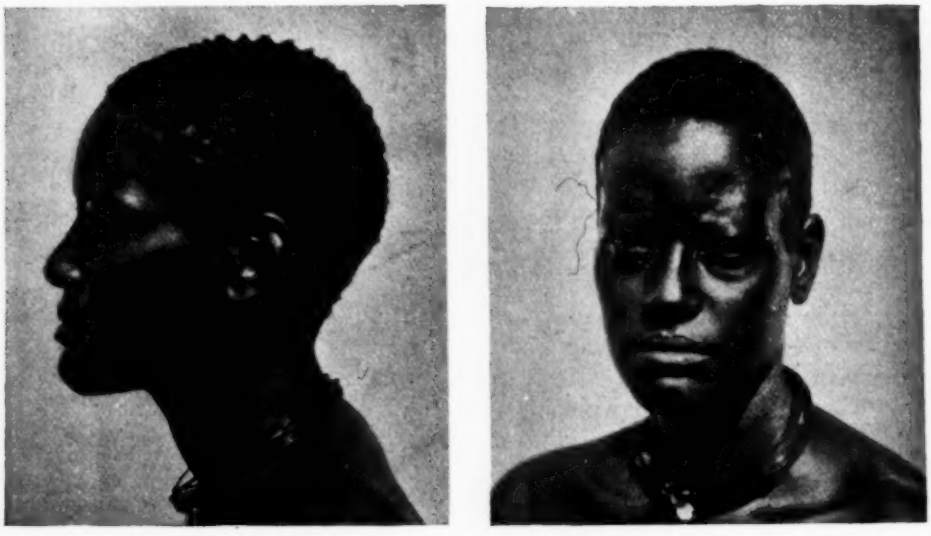
and Maurel, on Indonesia and the western Pacific. For special details *vide* Balz, on Japan; Man, on the Andamans; and others. For Africa and Australia the results are certain but scattered through a number of less extended investigations. Then there is the more general work of Weisbach, Broca, Pruner Bey, and others. All these have been checked or supplemented by the large collections of observations on the cranium. A complete bibliography, as detailed as the one provided for Europe, will be published in due time. It will never cease to be a matter of regret that observers like Paulitschke, Ehrenreich, Hartmann, Fritsch, Finsch, the Sarasin brothers, Stanley, and others, offer no material for work of this kind. For the location of tribes we have used Gerland's Atlas für Volkerkunde. It is to be hoped that Dr. Boas's map for North America, now ready for publication, may not long be delayed.

* Ernst Haeckel, in his Anthropogenie, gives an interesting map with a restoration of this continent as a center of dispersion for mammals.

human equator of the earth. Such is as it should be; for while the greatest extremes of environment are offered between the steaming plains of the Ganges and the frigid deserts and steppes of the north, at the same time direct intercourse between the two regions has been rendered well-nigh impossible by the height of the mountain chain itself. In each region a peculiar type has developed without interference from the other. At either end of the Himalayas proper, where the geographical barriers become less formidable, and especially wherever we touch the sea, the extreme sharpness of the human contrasts fails. The Chinese manifest a tendency toward an intermediate type of head form.



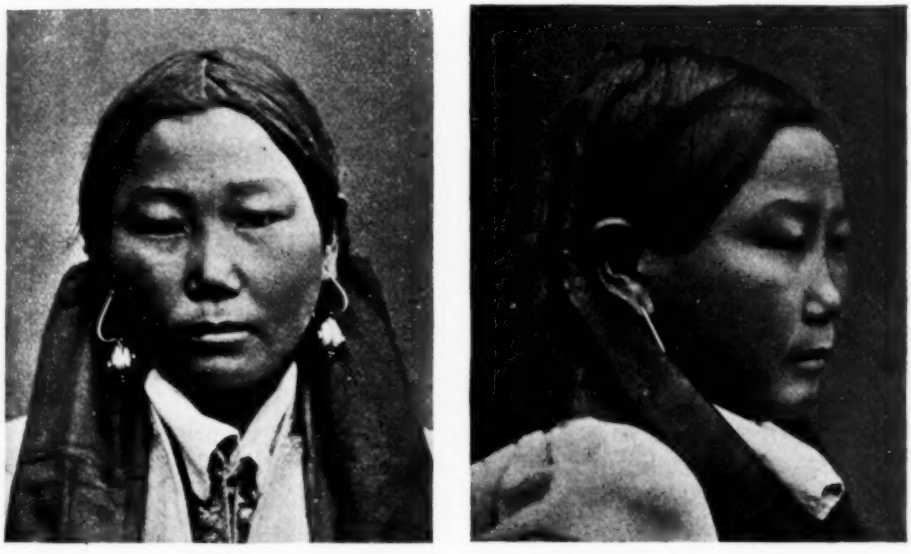
NEGRO TYPE, CENTRAL AFRICA. Cephalic Index, 70±.

Japan shows it even more clearly. From China south the Asiatic broad-headedness becomes gradually attenuated among the Malays, until it either runs abruptly up against the Melanesian dolichocephalic group or else vanishes among the islanders of the Pacific. Evidence that in thus extending to the southeast the Malays have dispossessed or absorbed a more primitive population is afforded by the remnants of the negritos. These black people still exist in some purity in the inaccessible uplands of the large islands in Malaysia.

Compared with the extreme forms presented in the Old World, the Americas appear to be quite homogeneous and at the same time intermediate in type, especially if we except the Eskimo; for in the western hemisphere among the true Indians the extreme variations of head form are comprised between the cephalic indices of 85 in British Columbia and Peru, and of 76 on the southeast coast of Brazil. Probably nine tenths of the native

tribes of America have average indices between 79 and 83. Many American peoples among whom customs of cranial deformation prevail are able artificially to raise their indices to 90 or even 95; but such monstrosities should be excluded for the present, since we are studying normal types of man alone. Translated into words, this means that the American Indians should all be classified together as, in a sense, a secondary race.

With them we may place the great group of men which inhabits the islands of the Pacific. These people manifest even clearer than do the American Indians that they are an intermediate type. They are, however, more unstable as a race, especially



KALMUCK GIRL, WESTERN ASIA. Cephalic Index, 86.

lacking homogeneity. They seem to be compounded of the Asiatic and Melanesian primary racial elements in varying proportions. It is the most discouraging place in the world to measure types of head, because of their extreme variability. We shall have occasion shortly to compare certain of their characteristics other than the head form with those of the people of Europe. This we shall do in the attempt to discover whether these last are also a secondary race, or whether they are entitled to a different place in the human species. We shall then see that one can not study Europe quite by itself without gaining thereby an entirely false idea of its human history.

Before proceeding to discuss the place which Europe occupies in our racial series, it may be interesting to point out certain curious parallelisms between the geographical localization of the several types of head form and the natural distribution of the

flora and fauna of the earth. Where, as in Africa and Australia, there is marked individuality in the lower forms of life, there is also to be found an extreme type of the human species. Where, on the other hand, realms, like the Oriental one which covers southeastern Asia and the Malay Archipelago, have drawn upon the north and the south alike for both their flora and fauna, several types of man have also immigrated and crossed with one another. Often the dividing lines between distinct realms for varieties of man, animal, and plant coincide quite exactly. The Sahara Desert, once a sea, and not the present Mediterranean, as we shall show, divides the true negro from the European, as it does the Ethiopian zoölogical and botanical realm from its neighbor. Thus the Berber of Tunis, on page 580, is properly placed in our series of European types. The Andes, the Rocky Mountains, and the Himalayas, divide types of all forms of life alike, including man. Even that remarkable line which Alfred Russel Wallace so vividly describes in Island Life, which divides the truly insular fauna and flora from those of the continent of Asia, is duplicated among men near by. The sharp division line for plants and animals between Bali and Lombok we have shown upon the map. It is but a short distance farther east, between Timor and Flores, where we suddenly pass from the broad-headed, straight-haired Asiatic Malay to the long-headed and frizzled Melanesian savage—to the group which includes the Papuans of New Guinea and the Australian.*

Following out this study of man in his natural migrations just as we study the lower animals, it can be shown that the differences in geographical localization between the human and other forms of life are merely of degree. The whole matter is reducible at bottom to terms of physical geography, producing areas of characterization. Where great changes in the environment occur, where oceans or mountain chains divide, or where river systems unite geographical areas, we discover corresponding effects upon the distribution of human as of other animal types. This is not because the environment has directly generated those peculiarities in each instance; certainly no such result can be shown in respect of the head form. It is because the several varieties of man or other mammals have been able to preserve their individuality through geographical isolation from intermixture, or contrariwise, as the case may be, have merged it in a conglomerate whole compounded of all immigrant types alike. In this sense man in his physical constitution is almost as much a creature of environment as the lower orders of life. Even in Europe he has not yet

* A good ethnological map of this region is given in Fr. Ratzel's History of Mankind, i, p. 144.

wholly cast off the leading strings of physical circumstance, as it is our purpose ultimately to show.

By this time it will have been observed that the differences in respect of the head form become strongly noticeable only when we compare the extremes of our racial series; in other words, that while the minor gradations may be real to the calipers and tape, they are not striking at first glance to the eye. As a matter of fact, it is the modesty of this physical trait—not forcing itself conspicuously upon the observer's notice as do differences in the color of the skin, the facial features, or the bodily stature—which forms the main basis of its claim to priority as a test of race. Were the head form as strikingly prominent as these other physical traits, it would tend to fall a prey to the modifying factor of artificial selection: that is to say, it would speedily become part and parcel among a people of a general ideal, either of racial beauty or of economic fitness, so that the selective choice thereby induced would soon modify the operation of purely natural causes. However strenuously the biologists may deny validity to this element of artificial selection among the lower animals, it certainly plays a large part in influencing sexual choice among primitive men and more subtly among us in civilization. Just as soon as a social group recognizes the possession of certain physical traits peculiar to itself—that is, as soon as it evolves what Prof. Giddings has aptly termed a "consciousness of kind"—its constant endeavor thenceforth is to afford the fullest expression to that ideal. Thus the nobility in Japan are as much lighter in weight and more slender in build than their lower classes as the Teutonic nobility of Great Britain is above the British average. The Japanese aristocracy in consequence might soon come to consider its bodily peculiarities as a sign of high birth. That it would thereafter love, choose, and marry—unconsciously perhaps, but no less effectively—in conformity with that idea is beyond peradventure.

Is there any doubt that where, as in our own Southern States, two races are socially divided from one another, the superior would do all in his power to eliminate any traces of physical similarity to the menial negroes? Might not the Roman nose, light hair and eyes, and all those prominent traits which distinguished the master from the slave, play an important part in constituting an ideal of beauty which would become highly effective in the course of time? So uncultured a people as the natives of Australia are pleased to term the Europeans, in derision, "tomahawk-noses," regarding our primary facial trait as absurd in its make-up. Even among them the "consciousness of kind" can not be denied as an important factor to be dealt with in the theory of the formation of races.

Such an artificial selection is peculiarly liable to play havoc with facial features, for which reason these latter are rendered quite unreliable for purposes of racial identification. And yet, because they are entirely superficial, they are first noted by the traveler and used as a basis of classification. A case in point is offered by the eastern Eskimos, who possess in marked degree not only the almond eye, so characteristic of the Mongolian peoples, but also the broad face, high cheek bones, and other features common among the people of Asia. Yet, notwithstanding this superficial resemblance, inspection of our world map of the head form shows that they stand at the farthest remove from the Asiatic type. They are even longer-headed than most of the African negroes. Equally erroneous is it to assume, because the Asiatic physiognomy is quite common among all the aborigines of the Americas, even to the tip of Cape Horn, that this constitutes a powerful argument for a derivation of the American Indian from the Asiatic stock. We shall have occasion to point out from time to time the occurrence of local facial types in various parts of Europe. On the principle we have indicated above, these are highly interesting as indications of a local sense of individuality, but they mean but little, so far as racial origin and derivation are concerned.

Happily for us, racial differences in head form are too slight to suggest any such social selection as has been suggested; moreover, they are generally concealed by the headdress, which assumes prominence in proportion as we return toward barbarism. Obviously, a Psyche knot or savage peruke suffices to conceal all slight natural differences of this kind; so that Nature is left free to follow her own bent without interference from man. The color of skin peculiar to a people may be heightened readily by the use of a little pigment. Such practices are not infrequent. To modify the shape of the cranium itself, even supposing any peculiarity were detected, is quite a different matter. It is far easier to rest content with a modification of the headdress, which may be rendered socially distinctive by the application of infinite pains and expense. It is well known that in many parts of the world the head is artificially deformed by compression during infancy. This was notably the case in the Americas. Such practices have obtained and prevail to-day in parts of Europe. For example, the people about Toulouse in the Pyrenees are accustomed to distort the head by the application of bandages during the formative period of life. This deformation * is sometimes so extreme

* For a full account of such deformation, *vide* L'Anthropologie, Paris, vol. iv, p. 11, *seq.* The illustrations of such deformation, of the processes employed, and of the effect upon the brain development, are worthy of note.

as to equal the Flathead Indian monstrosities which have been so often described. Fortunately, these barbarous customs are rare among the civilized peoples which it is our province to discuss. Their absence, however, can not be ascribed to inability to modify the shape of the head; rather does it seem to be due to the lack of appreciation that any racial differences exist, which may be exaggerated for social effect or racial distinction.

Another equally important guarantee that the head form is primarily the expression of racial differences alone, lies in its immunity from all disturbance from physical environment. As will be shown subsequently, the color of the hair and eyes, and stature especially, are open to modification by local circumstances; so that racial peculiarities are often obscured or entirely reversed by them. On the other hand, the general proportions of the head seem to be uninfluenced either by climate, by food supply or economic status, or by habits of life; so that they stand as the clearest exponents which we possess of the permanent hereditary differences within the human species.* Ranke, of Munich, with Virchow, the leader of anthropological science in Germany, has long advocated a theory that there is some natural relation between broad-headedness and a mountainous habitat. He was led to this view by the remarkable Alpine localization, which we shall speedily point out, of the brachycephalic race of Europe. Our map of the world, with other culminations of this type in the Himalayan plateau of Asia, in the Rocky Mountains, and the Andes, may seem to corroborate this view. Nevertheless, all attempts to trace any connection in detail between the head form and the habitat have utterly failed. For this reason we need not stop to refute it by citing volumes of evidence to the contrary, as we might.† Our explanation for this peculiar geographical phenomenon, which ascribes it to a racial selective process alone, is fully competent to account for the fact. The environment is still a factor for us of great moment, but its action is merely indirect. In the present state of our knowledge, then, we seem to be justified in ruling out environment once and for all as a direct modifier of the shape of the head.

Having disposed of both artificial selection and environment as possible modifiers of the head form, nothing remains to be eliminated except the element of chance variation. This last is

* For a curiously old-fashioned statement of the exact opposite of this view, see A. H. Keane's Ethnology, recently published by Macmillan, pp. 43 and 177. There is one custom which is effective. The peoples who use hard cradles or wooden pillows for infants' use are undoubtedly modified in head form by it. This is a disturbing factor in the Americas, and to some extent in parts of Europe.

† This theory is best stated in J. Ranke, Beiträge zur physischen Anthropologie der Bayern, Part I, chap. ii, p. 75 *seq.*

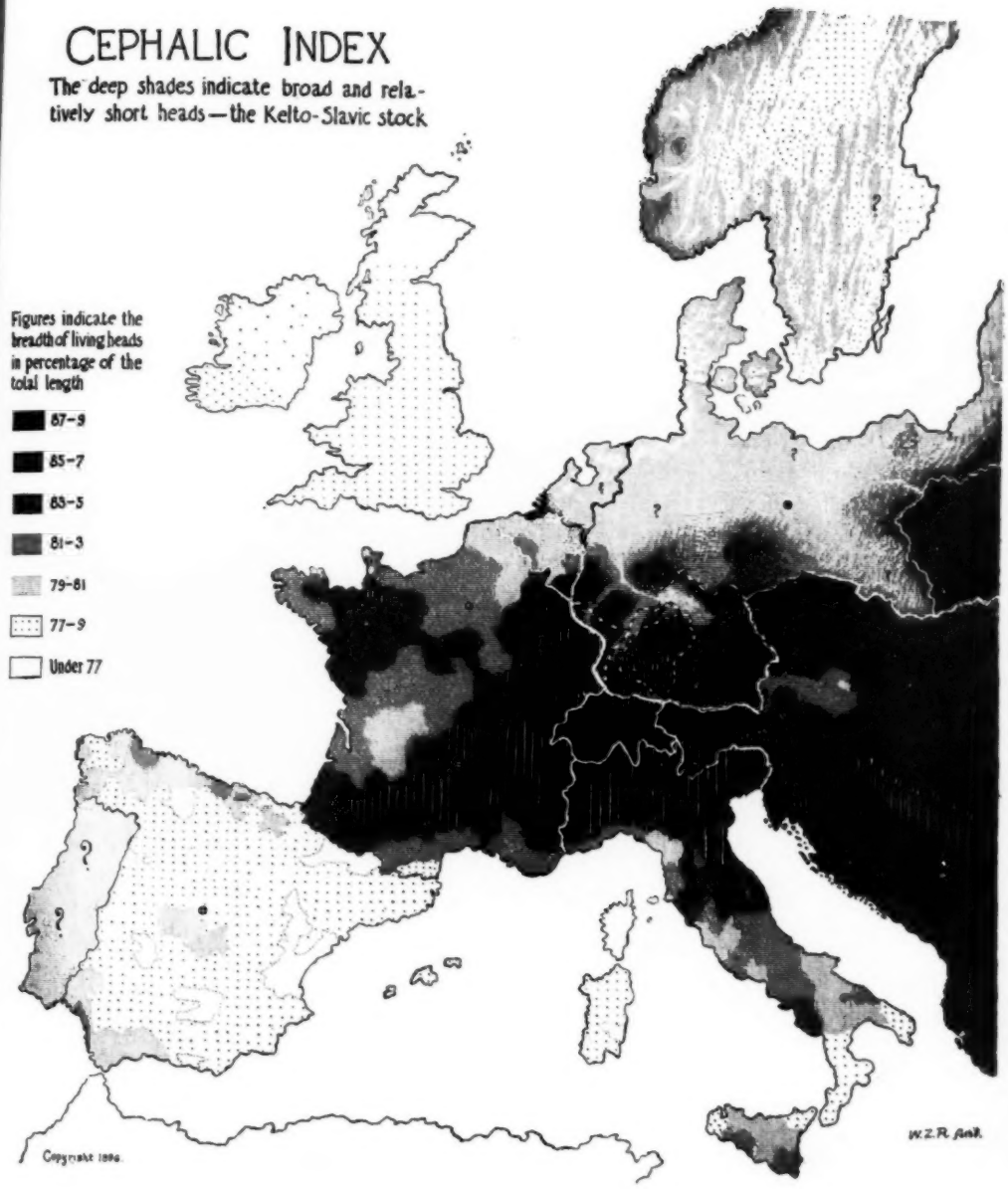
readily counterbalanced by taking so many observations that the fluctuations above and below the mean neutralize one another. Variation due to chance alone is no more liable to occur in the head than in any other part of the body. Rigid scientific methods are the only safeguard for providing against errors due to it. It is this necessity of making the basis of observation so broad that all error due to chance may be eliminated, which constitutes the main argument for the study of heads in the life rather than of skulls; for the limit to the number of measurements is determined by the perseverance and ingenuity of the observer alone, and not by the size of the museum collection or of the burial place. It should be added that our portraits have been especially chosen with a view to the elimination of chance. They will always, so far as possible, represent *types* and not *individuals*, in the desire to have them stand as *illustrations* and not merely *pictures*. This is a principle which is lamentably neglected in many books on anthropology; to lose sight of it is to prostitute science in the interest of popularity.

The most conspicuous feature of our map of cephalic index for western Europe * is that here within a limited area all the extremes of head form known to the human race are crowded together. In other words, the so-called white race of Europe is not physically a uniformly intermediate type in the proportions of the head between the brachycephalic Asiatics and the long-headed negroes of Africa. A few years ago it was believed that this was true. More recently, detailed research has revealed hitherto unsuspected limits of variation. In the high Alps of northwestern Italy are communes with an average index of 89, an extreme of round-headedness not equaled anywhere else in the world save in the Balkan Peninsula and in Asia Minor. A typical Italian from this district, chosen for me by Dr. Livi, of Rome, from among three regiments of recruits, is shown on page 581. In profile the back of the head is even less developed than that of the Kalmuck girl in our illustration. This type of head prevails all through the Alps, quite irrespective of political frontiers. These superficial boundaries are indicated in white lines upon the map to show their independence of racial limits. There is no essential difference in head form between the Bavarians and

* Complete technical details by the author as to the mode of construction, with full references for each portion of the continent, will be found in L'Anthropologie, Paris, vol. vii, pp. 513 *seq.* Since the above map was drawn, certain minor changes have been made, in conformity with suggestions received from European experts. They all appear in the map in L'Anthropologie to which reference is here made; most of them were so unimportant for present purposes that this map was left unchanged. The only serious modification would be to make Silesia much darker, as I believe it to be less Teutonized than this map indicates.

CEPHALIC INDEX

The deep shades indicate broad and relatively short heads—the Kelto-Slavic stock



the Italian Piedmontese, or between the French Savoyards and Tyrolese.

From what has been said, it will appear that these Alpine populations in purity exceed any known tribes of central Asia in the breadth of their heads. Yet within three hundred miles, as the crow flies, in the island of Corsica, are communes with an average cephalic index of 73. These mountaineers of inland Corsica are thus as long-headed as any tribe of Australians, the wood Veddahs of Ceylon, or any African negroes of which we have extended observations. A little way farther to the north there are other populations in Scotland, Ireland, and Scandinavia which are almost as widely different from the Alpine peoples in the proportions of the head as are the Corsicans. An example of extreme individual variation downward is shown in our illustrated Teutonic type, which has a lower index than any recorded for the longest-headed primitive races known. Nor is this all. Pass to northern Scandinavia, and we find among the Lapps again, one of the broadest-headed peoples of the earth, of a type shown in our series of portraits.

So remarkably sudden are these transitions that one is tempted at first to regard them as the result of chance. Further examination is needed to show that it must be due to law. Proof of this is offered by the map itself; for it indicates a uniform gradation of head form from several specific centers of distribution outward. Consider Italy, for example, where over three hundred thousand individuals, from every little hamlet, have been measured in detail. The transition from north to south is perfectly consistent. The people of the extreme south are like the Tunisian shown in our portrait; while at the knee of Italy, halfway up, the mean type in our series of illustrations stands between the two geographical extremes in its proper place. So it is all over the continent. Each detailed research is a check on its neighbor. There is no escape from the conclusion that we have to do with law.

Two distinct races of man, measured by the head form alone, are to be found within the confines of this little continent. One occupies the heart of western Europe as an outpost of the great racial type which covers all Asia and most of eastern Europe as well. The other, to which we as Anglo-Saxons owe allegiance, seems to hang upon the outskirts of Europe, intrenched in purity in the islands and peninsulas alone. Northern Africa, as we have already observed, is to be classed with these. Furthermore, this long-headed type appears to be aggregated about two distinct centers of distribution—in the north and south respectively. In the next paper we shall show that these two centers of long-headedness are again divided from one another in respect of both color of hair and eyes and stature. From the final combination

of all these bodily characteristics we discover that in reality in Europe we have to do with three physical types and not two. Thus we reject at once that old classification in our geographies of all the peoples of Europe under a single title of the white, the Indo-Germanic, or Aryan race. Europe, instead of being a monotonous entity, is a most variegated patchwork of physical types. Each has a history of its own, to be worked out from a study of the living men. Upon the combination of these racial types in varying proportions one with another the superstructure of nationality has been raised.

Among other points illustrated by our map of Europe is the phenomenon paralleled in general zoölogy, that the extreme or pure type is generally to be found in regions of marked geographical individuality. Such areas of characterization occur, for example, in the Alpine valleys, in Corsica and Sardinia, somewhat less so in Spain, Italy, and Scandinavia. The British Isles, particularly Ireland, at least until the full development of the art of navigation, afforded also a good example of a similar area of characterization. Europe has always been remarkable among continents by reason of its "much-divided" geography. From Strabo to Montesquieu political geographers have called attention to the advantage which this subdivision has afforded to man. They have pointed to the smooth outlines of the African continent, for example, to its structural monotony, and to the lack of geographical protection enjoyed by its social and political groups. The principle which they invoked appears to hold true in respect of race as well as of politics. Africa is as uniform racially as Europe is heterogeneous.

Pure types physically are always to be found outside the great geographical meeting places. The latter, such as the garden of France, the valleys of the Po, the Rhine, and the Danube, have always been areas of conflict. Competition, the opposite of isolation, in these places is the rule, so that progress which depends upon the stress of rivalry has followed as a matter of course. There are places where too much of this healthy competition has completely broken the mould of nationality, as in Sicily, so ably pictured by the late Mr. Freeman. It is only within certain limits that struggle and conflict make for an advance forward or upward. Ethnically, however, this implies a variety of physical types in contact, from which by natural selection the one best fitted for survival may persist. This means ultimately the extinction of extreme types and the supersession of them by mediocrity. In other words, applying these principles to the present case, it implies the blending of the long and the narrow heads and the substitution of one of medium breadth. The same causes, then, which conduce socially and politically to progress have as

an ethnic result mediocrity of type. The individuality of the single man is merged in that of the social group. In fine, contrast of race is swallowed up in nationality. This process has as yet only begun in western Europe. In the so-called upper classes it has proceeded far, as we shall see. We shall, in due course of time, have to trace social forces now at work which insure its further prosecution not only among the leaders of the people, but among the masses as well. The process will be completed in that far-distant day when the conception of common humanity shall replace the narrower one of nationality; then there will be perhaps not two varieties of head form in Europe, but a great common mean covering the whole continent. The turning of swords into plowshares will contribute greatly to this end. Modern industrial life with its incident migrations of population does more to upset racial purity than a hundred military campaigns or conquests. Did it not at the same time invoke commercial rivalries and build up national barriers against intercourse, we might hope to see this amalgamation completed in a conceivable time.

EXPERIMENTS ON THE PHYSIOLOGY OF ALCOHOL, MADE UNDER THE AUSPICES OF THE COMMITTEE OF FIFTY.

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I.

THE following is Dr. J. S. Billings's statement on behalf of the committee: "This paper contains an account of some research work which has been done for the Committee of Fifty for the Investigation of the Liquor Problem, and it is to be regarded as merely a preliminary report to be considered in the final conclusions which may be reached in the future by the Committee of Fifty itself."

On my own part I desire to express to the Committee of Fifty my deep sense of appreciation for the support which has made the following researches possible. To the members of the Subcommittee on Physiology, Drs. Bowditch, Billings, Chittenden, and Welch, my especial thanks are due for hearty and sustained interest and prompt assistance at every turn of the investigation. Under their stimulus and guidance it has been throughout the keenest pleasure to work, even upon a problem so beset with prejudices that the slightest contamination of the atmosphere of pure science, in which such work, if ever effectual, must be done, would have rendered even the will to undertake it impossible.

The general point of view may be indicated in a few words. For centuries opinion has been divided on the subject, and the human experiment has been repeated, generation after generation, by individuals and on a national scale. But man is the most highly complex, most variable, most adaptable of animals, and the human problem has proved itself too complicated for scientific interpretation. Some men fail with alcohol, others fail as completely without it, and the same is true of success. Even "statistics relating to inebriety are too confusing," we find admitted in the Quarterly Journal of Inebriety.*

Some may contend that the alcohol problem does not depend upon the science of physiology for its solution; but rather upon the moral, religious, or political functions of society. It should be remembered, however, that physiology is a broad science, whose ultimate aim is no less than to discover the laws and conditions under which may be developed the highest possible type of man. By the intimate correlations between body and mind, and under the recent outgrowths of the mother science into modern psychology and neurology, physiology would cover the whole man, body, mind, and soul. And it would have not only a healthy soul and a sound mind in a sound body, but the most perfect soul, mind, and body which can be developed under physical conditions. Thus problems touching human welfare, even questions of ethics and social science, must ever draw important factors for their solutions from this science which is fundamental to the conditions and processes of life itself.

Extreme difficulty in solving such complicated equations is in part accountable for our lack of definite knowledge. But even this, it seems to me, does not constitute the most serious hindrance to the progress of science. In this country our greatest obstacle consists in a deficient notion as to what constitutes a scientific answer to a question. We are far too prone to say we "know" a thing is "true," when we lack sufficient evidence to convince an unprejudiced person of the fact. We mean simply that we "think," or we "guess," or we have a strong "prejudice" that such and such is the fact. Affirmation and prejudice are promptly met by contra-affirmation and prejudice, and with people who are satisfied with this sort of procedure scientific advance is at a standstill. We are too slow to realize that all progress in knowledge depends upon accumulation of wholly impartial evidence. Lacking this, no amount of legislating and voting and vociferating, can lay a smallest gravel corn of truth in the roadbed of human progress. As Bacon said so long ago, concerning the man who loses sight of this distinction and clothes his own

* Kinney, C. Spencer, M. D. The Quarterly Journal of Inebriety, 1896, p. 223.

beliefs with the reality of fact, "He shall exchange things for words, reason for insanity, the world for a fable, and shall be unable to interpret."

To meet difficulties connected with the intricacies and complexities of the problem, the method of physiology is clearly to reduce the equations to their simplest possible terms. By studying the physiology of alcohol in a number of simpler organisms, sufficient light may be thrown on the human experiment to render its interpretation possible. A unicellular organism is millions times less complicated than a human body; still, fundamental activities, nutrition, excretion, growth, reproduction, appear similar in both. So, too, the lower animals are proportionally simpler and also approach man physiologically more closely for purposes of comparison. Their conditions of life, too, can be made far more nearly comparable than it would be possible to either find or procure with men. With man, even after death, the microscopical study of the tissues to demonstrate the influence of alcohol upon them is so complicated by conditions of disease and post-mortem changes that no wholly trustworthy evidence is obtainable.* On the other hand, animals may be killed in known conditions of health, and their tissues immediately prepared for examination; and in this way results have already been obtained by Berkley,† Dehio,‡ Stewart,* and others, which have materially assisted in the interpretation of uncertain findings in human material.

Such a series of experiments should clearly be made on a number of different organisms, both plants and animals, in order that our basis for comparison and judgment may be sufficiently broad to enable us to distinguish between the constant and general effects of alcohol from those which are accidental or exceptional. And observations should be continued long enough to bring out clearly any more remote effects, especially those relating to heredity, of great importance, and about which much has been said but practically nothing is known.

It is intended in the following to outline the results of three series of experiments. Although necessarily incomplete in many ways, they may serve to demonstrate methods of research, and to show some of the possibilities of further work.

I. Experiments upon the Growth of Yeast.—The yeast plant, when sown in a nutrient solution, discloses an almost

* Berkley, H. J. The Effects of Alcohol on the Central Nervous System. Quarterly Journal of Inebriety, 1896, p. 109.

† Ibid. Studies on the Lesions produced by the Action of Certain Poisons on the Cortical Nerve Cell. I. Alcohol. Brain, 1895, p. 473.

‡ Dehio, H. Centralblatt für Nervenheilkunde und Psychiatrie, 1895.

* Stewart, C. C. Journal of Experimental Medicine, 1896.

incredible power of growth and reproduction. This growth is wholly controlled by external conditions and by the composition of the nutrient medium. Probably no form of life approaches in power of rapid reproduction these minutest plants, the bacteria and yeasts, and none are probably more delicately responsive to varying conditions of life.

Yeast is able to grow until, by decomposition of sugar, its medium comes to contain fourteen per cent * of common alcohol. At this point, no matter how much sugar and other nutriment remains, further growth is impossible.

Now, of especial interest to the physiology of nutrition, and the influence upon it of waste products generally, is the question,

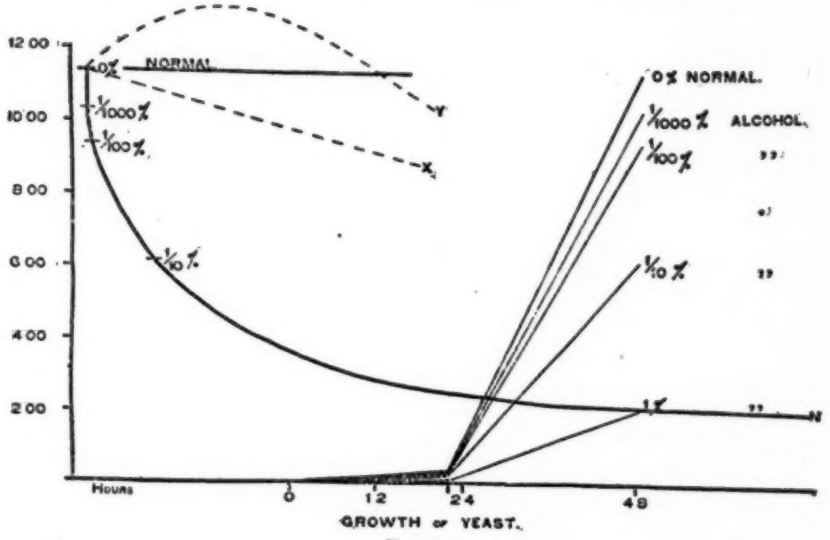

FIG. 1.

What effect have very minute quantities of alcohol on the growth of yeast?

Fig. 1 represents to the eye, in the diagram to the left, the four possible kinds of action in the four lines diverging from the point marked "0 per cent." If no slowing effect is present until the poison limit, fourteen per cent, is reached, the line marked "normal" should be continued out until directly over a point corresponding to fourteen per cent strength of solution, and then should drop perpendicularly to the zero point of growth on the base line. As a matter of fact, Flügge states that growth is slowed with twelve per cent and stopped at fourteen per cent. If this be true, instead of dropping vertically, it would fall a little obliquely from twelve per cent to fourteen per cent. This

* Flügge, C. Die Mikroorganismen. Leipsic, 1886, p. 482.

would mean that up to a very high limit of concentration alcohol is absolutely harmless, that at a certain point it becomes suddenly toxic, and that slight increase beyond this concentration worked very rapidly to bring growth to a standstill.

A second possibility would be represented by a straight line, "Z," dotted line, falling uniformly from zero per cent to fourteen

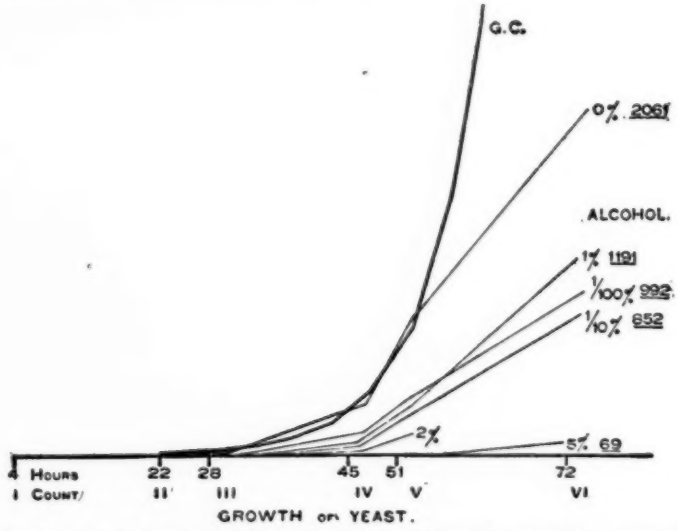

FIG. 2.—G. C., curve of a geometrical progression increasing at the rate of yeast growth in the normal cultures for the first twenty-four hours. The numbers at the right indicate the number of *torulæ* found in a cubic millimetre of the different cultures.

per cent. This would indicate that the effect of the presence of alcohol in the culture medium upon yeast growth was a purely mechanical effect, a matter of friction, a clogging of the molecules, as it were. This would signify, the less alcohol the better, but that a small quantity has a comparatively slight effect, and that probably no harm is done in the way of changing the chemical reactions concerned in the growth processes of the yeast plant.

A third possibility, represented by dotted line "Y" in the figure, is in line with an idea not infrequently carried into practice, viz., that a little alcohol increases, "stimulates," activity, a larger quantity interferes with it. If this were found to be the case, the important matter to determine would be at what point of concentration alcohol ceases to be beneficial.

The heavy line, "M," represents the fourth possibility, viz., that minute amounts of alcohol have relatively a much greater retarding effect upon the growth of yeast than larger amounts. The line is plotted from the results of a series of experiments, of which a different expression is given in the diagram to the right in the figure. One thousandth of one per cent is seen to cause

a considerable retardation of growth, over half as much as ten times the amount in one hundredth of one per cent, and about one fifth as much as the retardation caused by one hundred times as much alcohol, one tenth of one per cent. That is to say, we find a truly physiological curve, of practically the same form as that obtained from the fatigue of a muscle fiber or a nerve cell. This is not so remarkable, since in all such experiments we are touching, in final analysis, the vital activities of living cells, and in muscle or nerve one of the prime factors in causation of fatigue is accumulation of the waste products of active metabolism.

In the right-hand diagram in Fig. 1 and in Fig. 2 the same fact is expressed as a race—a competitive effort—in which the culture containing no alcohol is seen to win, the others falling behind. In general, retardation of growth is directly proportional to amount of alcohol. This is the unmistakable result of the entire series of experiments, fifteen in number. In Fig. 2, however, it may be noted that the cultures containing one per cent have grown somewhat better than those of 0·1 and 0·01 per cent. This is clearly due to difficulties in uniformly "seeding" the cultures, and when these were overcome perfectly consistent results, as seen in Fig. 1, were obtained.*

Too great caution can not be used in interpreting the above results. While the physiology of the yeast cell and that of the cells of the human body may be at ground similar, in certain particulars they may be widely different. The yeast cell has not the power to oxidize alcohol. The cells of the body, or some of them at least, are most certainly able to bring about this reaction. Furthermore, if we had experimented with *Mycoderma aceti*—the normal food of which alcohol seems to be—we should have doubtless obtained a diametrically opposite result.

On the other hand, ethyl alcohol is found in minute quantities in the fresh tissues of man and animals where no alcohol has been given as a constant normal constituent. It has been distilled off from the brain, muscle, and liver.† Whether it exists as a food in process of transformation or as a waste product, as in case of the yeast cell; whether it is a waste product from the activity of

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* *S. cerevisiæ*, obtained in pure culture from Fleischmann's compressed yeast, was used throughout these experiments. The chief difficulty encountered consisted in breaking up the large clusters, composed of hundreds of torulæ, so as to get a uniform seeding suspension. This was finally done by churning the culture from which it was desired to seed with a wad of sterilized absorbent cotton. The liquid squeezed out of the cotton contained only single torulæ. The seeding was always done from fresh stock solution—i. e., it was free from alcohol.

† Rajewski. Pflüger's Archiv, Bd. ii, S. 122. Hoppe-Seyler. Handbuch der chemischen Analyse, Berlin, 1893, S. 40 and 41.

some cells and a food for others, it is impossible to say. While these questions remain open, it might be safe to assume, that if a food, the tissues are possibly, in conditions of health, able to produce all they need of it. If it is mainly a waste product, they should not be burdened with any more of it than necessary.

II. EXPERIMENTS UPON KITTENS were broken in upon and complicated by accidents and disease to such an extent that we shall pass them by with a brief mention.

During April of 1895 four kittens were obtained,* the two males, which we will call 1 and 2, from the same litter; the two

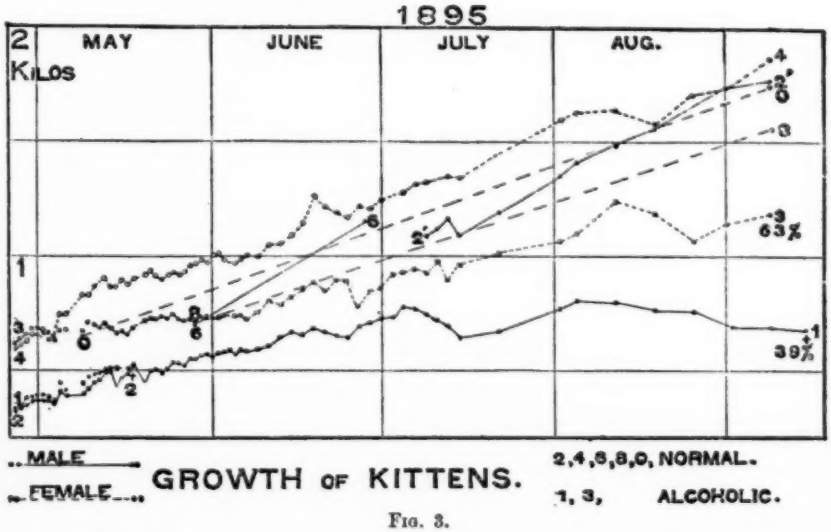


FIG. 3.

females, 3 and 4, from an unrelated litter. The males were born April 2d; the females, March 18th.

From April 23d to 29th they were weighed daily and studied as to health, liveliness, and general comparability. All four purred and played normally, but it was evident that 1 and 3 were considerably more vigorous and active. Both 2 and 4 had sore eyes—a rather serious indication of poor nutrition. Nevertheless, these were the most nearly comparable two pairs of kittens available at the time. Some doubts were entertained, but it was thought possible to bring 2 and 4 up to a comparable health level. Accordingly, allowing this much handicap to alcohol, it was decided to take the vigorous pair (1 and 3) for alcohol, and keep 2 and 4 for normal controls.

Alcohol, chemically pure, † was now given, beginning with a dose of 1·3 gramme per kilogramme of body weight April 29th.

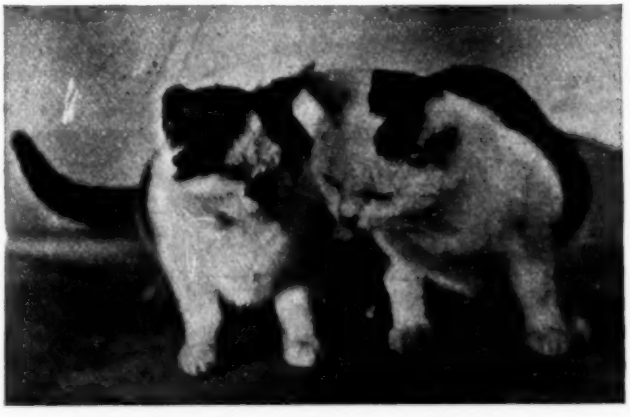
* Given by their respective owners with full knowledge as to the experiment to which they were to be submitted.

† Tested by evaporation at room temperature.

This dose caused scarcely appreciable intoxication, and was accordingly increased.* At about two grammes per kilogramme light intoxication with tendency to drowsiness became manifest. The dose was still further increased until May 7th to 9th, when it had reached 3·6 grammes per kilogramme. This produced characteristic symptoms of intoxication—restlessness, incoördination of muscles, which began with weakness and paralysis of the hind legs and worked forward. Sleep followed in from twenty to twenty-five minutes, and lasted from two to three hours. It was deep and quiet, but both kittens could be awakened without difficulty.

During this time both purring and playfulness had been rapidly disappearing from the lives of the alcoholic kittens, and by May 9th both had become obliterated, and both kittens were pictures of demure and forlorn sadness. May 10th the alcoholics had severe colds, with discharge of mucus from the eyes and nose. Alcohol was discontinued until recovery could be effected, but this proved impossible. Severe catarrh of the nasal passages with conjunctivitis set in, the catarrh proving incurable and becoming chronic.

The chief value of the experiment thus far is to be found in the possession of control normal animals. None of these had been



3 4

FIG. 4.—Kittens, November 27, 1895: 3, alcohol-diseased; 4, normal.

similarly affected. In fact, both 2 and 4 had improved greatly under good treatment and healthful conditions. It seems thus safe to conclude that alcohol, as administered, caused a sudden and general breakdown in the two kittens; but, while seen thus clearly

* It was first attempted to have the kittens take the alcohol mixed with warm milk. On their refusal to be thus imposed upon, it was given, diluted to twenty and thirty per cent, by stomach pump, always after meals, the normals being given an equal amount of water in the same manner.

as a cause at the beginning, there is no way of determining how long it continued to act. Hence, from this point on, the experiment becomes mainly a history of disease. Practically it is an equation in which we do not know whether there are one or two unknown quantities, hence absolutely unamenable to solution.

In Fig. 3 is graphically expressed the relations of growth for the four kittens above described, and also for several other normal kittens of about the same ages that I happened to have at the time. It is seen that the alcoholic-diseased animals are dwarfed in growth to sixty-three per cent and thirty-nine per cent respectively as compared with their normal controls (see also Fig. 4). Some might be inclined to find in this evidence of the "stunting" influence of alcohol when given to growing animals which Bevan Lewis* alludes to as "a well-known fact." This I was strongly inclined to do at first, but we are not warranted in doing so from the evidence in hand. In the autumn one of my normal kittens (not one of the four) contracted catarrh, and her growth was interrupted for a time in a similar way. Hence we are obliged to leave this important point entirely in abeyance for the present.

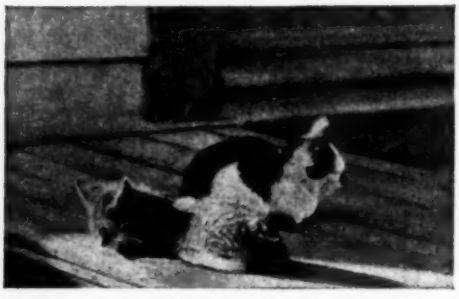


FIG. 5.—Alcohol-diseased kittens, 1 and 3, June 4, 1895: characteristic attitude. When the photograph was taken, 5 P. M., all the normal kittens were playing actively.

On the side of their psychological development the falling out of purring and play are matters of the most serious import. Soon after beginning alcohol my notes abound in such expressions as the following: "1 and 3 dosing, 2, 4, 0 (another kitten), all playing actively" (see Fig. 5). Along with this all the instincts characteristic of healthy kittens, care of coat, cleanliness, etc., were almost wholly annulled. Fear of dogs, hunting and game instincts, were completely lost. This psychic collapse, developing so suddenly as it did, would seem to be directly attributable to the influence of alcohol. At any rate, nothing of the sort approaching it in either kind or degree was manifested in the normal kittens during any of their periods of disease. It will be wise to bear these points in mind until further confirmation and further analysis of the experiment with kittens are possible. Among the animals thus far experimented with the cat seems to be by far the most sensitive to the influence of alcohol.

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* W. Bevan Lewis. A Text-Book of Mental Diseases. London, 1889, p. 306.

From subsequent details of the experiment, a highly sensational story might be manufactured, but that could have absolutely no scientific value. We must eschew all such temptations, and never allow the thought to be dimmed that Science has a mission to perform in the world as great as the universe and as sacred as truth. She is in duty bound to yield all benefits of doubt; and she commits moral and intellectual suicide, falling to the level of the common "insanity" described by Lord Bacon, when she insists upon a single iota not supported by "evidence."

[*To be continued.*]

PRINCIPLES OF TAXATION.

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VII.—RULES OR MAXIMS ESSENTIAL TO AN ADMINISTRATION OF RIGHTFUL TAXATION UNDER A CONSTITUTIONAL OR FREE GOVERNMENT.

A PRESENTATION and discussion of the rules or maxims of administration which are in conformity with the foregoing exposition and discussion of the origin and sphere of taxation, and the limitations on the exercise of this great power which are essential to the existence and continuance of a constitutional and free government, are next in order for the proper development and understanding of the general subject under consideration. Under such a government—one happily characterized and defined by President Lincoln as "of the people, by the people, and for the people"—the following rules or maxims governing the administration of its lawful taxation would seem to be almost in the nature of economic axioms:

First. *No tax should be imposed by a state or government except by the consent of the people from whom it is to be collected, given either directly or by their authorized representatives in Congress, Legislature, or Parliament assembled.*

Second. *All taxes or enforced contributions levied by the state in virtue of its sovereignty should be solely (singly) and exclusively for public purposes.*

Third. *The sphere of taxation should be limited to persons, property, and business exclusively within the territorial jurisdiction of the taxing power.*

Fourth. *Taxes should be reasonable, regular, and not arbitrary as respects method, time, and place of assessment and payment, and, above all, proportional.*

Fifth. *Taxation should not be employed as an agency or for*

the purpose of enforcing morality, or as an instrumentality for correction or punishment.

Sixth. *No tax should be levied the character and extent of which offer, as human nature is generally constituted, a greater inducement to the taxpayer to evade rather than pay.*

With a view of determining whether the above six propositions are so far fundamental and indisputable as to warrant their characterization as "economic axioms," attention is next asked to the following summary of reasons, or evidence to that effect, which may be separately adduced in respect to each one of them, commencing with the first—*that no tax should be imposed by a state or government except by the consent of the people from whom it is to be collected, given either directly or by their authorized representatives in Congress, Legislature, or Parliament assembled.* "The right is then wedded to the power, and representation and taxation become correlative." (*Miller, Justice S. F., on the Constitution.*)

It requires no great amount of thought to see that the principle involved in this proposition is not only an essential feature of every *just* system of taxation, but also the primary and essential condition of the existence of every system of free or popular government. If this is not at once apparent, the following brief historical retrospect ought to make it so:

The first great effort recorded in English history for its recognition and establishment as a fundamental principle of government was made by the English barons in 1215, in their notable struggle with King John, and resulted in the incorporation in the Great Charter (Magna Charta) of England of a provision which substantially forbade the king from imposing any taxes, except by permission of the General Council of the nation, duly summoned under writs regularly issued.* And it is interesting to note, as showing the broad spirit of generous patriotism that animated these rough old barons in their contest with King John, that they stipulated in the Magna Charta that they extorted from him that every limitation imposed in it for their protection upon the feudal rights of the king should be also imposed upon their rights as *mesne* lords (i. e., lords superior in the second degree) in favor of the undertenants who held of them.

In the many confirmations of the Great Charter in the ensuing reigns of Henry III and Edward I, its vital clauses as to

* The exact language of the charter was: "No scutage or aid shall be imposed in our kingdom unless by the general course of the nation, except for ransoming our person [i. e., the king], making our eldest son a knight, and once for marrying our eldest daughter; and for these there shall be taken a reasonable aid"; the barons in turn agreeing that "we will not for the future grant to any one that he may take aid of his own free tenants," other than the aids above stated.

taxation and the National Council were, however, invariably and intentionally omitted; and the latter king so reasserted the taxing power of the crown as to alarm the nation and occasion a revolution (Barons' War, 1297), which for many subsequent years prevented any like assumption on the part of Edward's successors. Under the reign of Charles I the authority to levy and collect taxes in England was, however, again claimed—as it was in all the other European states—to be vested exclusively in the king; and on the trial of John Hampden, in 1636, for his refusal to pay a tax known as "ship money," arbitrarily levied by the king for the maintenance of a naval force, this was the position taken by the crown lawyers representing the prosecution and accepted as valid by the judges in their verdict, the attorney general using in his plea language almost identical with that employed by Louis XIV, before cited, in defining his prerogative. (See Popular Science Monthly, No. 2, page 146, December, 1896.)

But when absolutism in government was overthrown in England in 1653, and a constitutional government established, no one principle was recognized as more fundamental than that the executive could levy no taxes except such as had been granted by the people taxed, through their representatives; and one of the very first statutes enacted by Parliament in 1689, under the reign of William and Mary, and accepted by the crown, was that all levying of money for the crown by pretense of prerogative should be hereafter and forever illegal; and next, in the latter third of the next century (1770), the unqualified affirmation and defense of the principle that those who pay the taxes should control the levying of them became the primary cause of the American Revolution, and eventuated in calling the United States into existence. And hence, by reason of such experiences, it has become a part of the common law of all English-speaking people that the taxing power inherent in the state is vested exclusively in the legislative department of its government.

Second. *All taxes or enforced contributions levied by a state in virtue of its sovereignty should be solely (singly) and exclusively for public purposes.*

Another and perhaps a more popular way of expressing this principle would be, to put it in the form of an affirmation, namely: *All taxes that the people pay, the government should receive.*

All recognized authorities, judicial and economic, are agreed in regarding the above proposition as in the light of a political axiom from which there can be no rational dissent. From a great number of confirmatory and illustrative legal opinions and decisions the following are especially worthy of attention:

"No State government, nor that of the United States, nor any other authority professing a regard for the rights of the people,

is at liberty to take money out of their pockets for any other than a public purpose. Whenever it can be discovered that a tax is levied for something which properly can not be called such, it may be successfully resisted by all the measures that the law allows in courts of justice."—*Miller, Justice S. F., Lectures on the Constitution of the United States, p. 242.*

"We have established, we think beyond cavil, that there can be no lawful tax which is not laid for a public purpose."—*Loan Association vs. Topeka, United States Supreme Court, 20 Wallace, p. 664.*

"Taxation, by the very meaning of the term, implies the raising of money for public uses, and excludes the raising of it for private objects and purposes."—*Allen vs. Inhabitants of Jay, 60 Maine* (per Appleton, C. J.).

"Taxation is allowable only for public purposes. The name (taxation) is not rightfully applied with reference to objects of a private nature, such as a bridge, manufactory, or foundry owned by individuals. An act of the Legislature authorizing a levy for a mere private purpose, or for a purpose which, though public, is one in which the people from which it is exacted have no interest, would not be a *law*, but a judicial sentence."—*Hillard, Law of Taxation, 1875.*

What are public purposes? This question is an embarrassing one, and in attempting to answer it there is opportunity for much latitude of opinion. In the first place, the ordinary or dictionary definition of the term "public," as forming a part of the above question, is certainly infelicitous and ambiguous—namely, "pertaining to a nation, state, or community; extending to the whole people" (Webster). Thus, for example, under a purely despotic form of government any exaction of contributions (taxes) from the people, and expenditures resulting therefrom, which the heads of the state may decree, be it for the expenses of a harem, the amusement or dignity of royalty, the reward or pensions of court favorites, or the maintenance of a military force for the subjugating of the people, would be held to be for a public purpose, and any subject that should undertake to contravene this assumption would be amenable to punishment and perhaps to the charge of treason.

On the other hand, under all popular or constitutional governments it would not probably be disputed, that taxation should have but one object and taxes but one destination—namely, to supply the expenses necessitated by those services which, according to established usage, it is the business of government to provide, and in contradistinction to those which private inclination, interest, or liberality will supply whenever a necessity or demand for such action becomes sufficiently manifest. Any form of levy,

therefore, under such a government upon the person or property of its citizens that does not conform to these conditions is not for a public purpose and is not entitled to be called taxation.

The following further amplification of these propositions by the Supreme Court of Massachusetts has probably also the unqualified indorsement of all judicial authorities in the United States:

"The incidental advantage to the public, or the State, which results from the promotion of private interests and the prosperity of private enterprise or business, does not justify their aid by the use of public money raised by taxation, or for which taxation may become necessary. It is the essential character of the direct object of the expenditure which must determine its validity as justifying a tax, and not the magnitude of the interest to be affected, nor the degree to which the general advantage of the community, and thus the public welfare, may be ultimately benefited by their promotion. *The principle of this distinction is fundamental. It underlies all government that is based upon reason rather than upon force."—Lowell vs. Boston, 111 Mass., 454.*

"It has become a favorite maxim that it is the duty of government to promote the happiness of the people. The phrase may be interpreted so as to mean well, but it is a very inaccurate and unhappy one. It is the inalienable right of men to pursue their *own* happiness, each man under such restraint of law as will leave every other man equally free to do the same. The happiness of the people is the happiness of the individuals who compose the mass. Speaking now with reference to those objects only which human laws can reach and influence, he is the happy man who sees his condition in life constantly and gradually, though it may be slowly, improving. Let government keep its hands off, do nothing in the way of creating the subject-matter of speculation, and things naturally fall into this channel."—*Sharswood, Legal Ethics.*

The distinction between a public and a private purpose in respect to taxation, however, is often a matter of great difficulty and embarrassment; and one eminent jurist and writer on taxation (Cooley) has indeed declared that "there is no such thing as drawing a clear line of distinction between purposes of a public and those of a private nature." But the question at issue has been so often made the subject of definition and illustration by the highest courts of the United States—speaking through jurists of the highest conceded ability—that, although complete unison of opinion does not now and probably never will exist as to whether certain particular purposes, as expenditures by the State for bounties, facilitating transportation, education, charities, amusements, celebrations, and the like, are within the requirements

to make them public. The sphere for disagreement has, however, within recent years greatly narrowed. One of the most clear and comprehensive of illustrations on this topic, given by the Supreme Court of Michigan (People *vs.* Township, 20 Michigan, 452), through Justice Thomas M. Cooley, was as follows:

In respect to "certain things of absolute necessity to civilized society," the State is precluded either by express constitutional provisions or by necessary implications, from providing for at all, and which are thus left wholly to the fostering care of private enterprise and private liberality. We concede, for instance, that religion is essential, and that without it we should degenerate to barbarism and brutality; yet we prohibit the State from burdening the citizen with its support, and we content ourselves with recognizing and protecting its observance on similar grounds. Certain professions and occupations in life are also essential, but we have no authority to employ the public money to induce persons to enter them. The necessity may be pressing and to supply it may be in a certain sense to accomplish a public purpose, but it is not a purpose for which the power of taxation may be employed. The public necessity for an educated, skillful physician in some particular locality may be great and pressing, yet, if the people should be taxed to hire one to locate there, the common voice would exclaim that the public moneys were being devoted to a private purpose. The opening of a new street in a city or village may be of trifling importance as compared with the location within it of some new business or manufacture; but while the right to pay out the public funds for the one would be unquestionable, the other by common consent is classified as a private interest which the public can aid as individuals, if they see fit, while they are not permitted to employ the machinery of government to that end. Indeed, the opening of a new street in the outskirts of a city is generally very much more a matter of private interest than of public concern; yet, even in a case where the public authorities did not regard the street as of sufficient importance to induce their taking the necessary action to secure it, it would not be doubted that the moment they should consent to so accept it as a gift, the street would at once become a public object and purpose upon which the public funds might be expended with no more restraints upon the action of the authorities in that particular than if it were the most prominent and essential thoroughfare in the city.

By common consent, also, a large portion of the most urgent needs of society are relegated exclusively to the law of demand and supply. It is this in its natural operation and without the interference of the Government that gives us the proper proportion to tillers of the soil, artisans, manufacturers, merchants, and professional men, and that determines when and where they shall give to society the benefit of their particular services. However great the need in the direction of any particular calling, the interference of Government is not tolerated, because, though it might be supplying a public want, it is considered as invading the domain that belongs exclusively to private inclination and enterprise. We perceive, therefore, that the term "*public purpose*," as employed to denote the objects for which taxes may be levied, has no relation to the urgency of the public need or to the extent of the public benefit which is to follow. It is, on the other hand, merely *a term of classification to distinguish the objects for which*,

according to settled usage, the Government is to provide, from those which, by the like usage, are left to private inclination, interest, or liberality.

Under a constitutional and representative form of government the determination of what constitutes a public purpose in respect to taxation rests primarily in the legislative department of such government; but legislative determination on this subject is not absolutely conclusive, for the question ultimately is one of law. If this was not so, a Legislature would possess unlimited power to make anything lawful which it might call taxation, which would be equivalent to an unlimited power to plunder the citizen.

In every case in which the Legislature shall have clearly exceeded its authority in this regard, and levied a tax for a purpose not public, it is competent for any one, who in person or property is affected by the tax, to appeal to the courts for protection.—*Cooley, Law of Taxation, p. 55.*

Brief references to certain other court cases, in which the validity of this claim that certain taxes, or acts involving the imposition of taxes, were for public purposes, was the question at issue, will also help to an understanding of the subject.

In 1872 the city of Boston was authorized by the Legislature of Massachusetts to issue bonds to the amount of $20,000,000, the proceeds to be loaned to persons whose property had been destroyed by a recent great fire. The Supreme Court of Massachusetts held that, although such "a promotion of the interests of individuals might result incidentally in the advancement of the public welfare," the measure was, "in its essential character, a private and not a public object," and therefore unconstitutional. (Lowell *vs.* Boston, 111 Mass.)

A similar statute enacted by the Legislature of South Carolina in aid of sufferers by a fire in Charleston was also declared by the Supreme Court of that State as unconstitutional. (Feldman & Co. *vs.* City of Charleston, S. C., 57.)

In 1870 the town of Jay, in Maine, voted to loan $10,000 to a firm of manufacturers, on condition that they would move their works to the town and establish and maintain them there for ten years. This vote, although ratified by an act of the Legislature, the Supreme Court of the State declared void. (Allen *vs.* Jay, 60 Maine, 124.)

In connection with this case the Legislature of the State of Maine officially put the following question to the justices of its Supreme Court: "Has the Legislature authority under the Constitution to pass laws enabling towns by gifts of money to assist individuals or corporations to establish or carry on manufacturing of various kinds within or without the limits of said towns?" The question was answered in the negative. The court used the following language: "There is nothing of a public nature any

more entitling the manufacturer to public gifts than the sailor, the mechanic, the lumberman, or the farmer. Our Government is based on an equality of rights. The State can not rightfully discriminate among occupations; *for a discrimination in favor of one branch of industry is a discrimination adverse to all other branches.* The State is equally bound to protect all, giving no undue advantage or special or exclusive preference to any. Taxation in aid of private enterprise is to load the tables of the few with bounty that the many may partake of the crumbs that fall therefrom."

In 1875 the Legislature of Kansas authorized townships to issue bonds for the purpose of raising money to be applied for the relief of such farmers within their limits as had been deprived, by a failure of crops, of seed with which to plant for a new season. This authorization was held by the court (Justice Brewer) to be unconstitutional, on the ground that the use of public moneys for the accommodation of a certain class was not a public purpose—"not for the benefit of the indigent, but of those who have fields to till and stocks to care for"—and that if the principle involved is once recognized, it may be invoked with equal propriety in aid of other or all classes. (State *vs.* Osawkee, 14 Kansas, 488.)

In the State of New York its Court of Appeals has held void an act of the Legislature authorizing a village to take stock in a manufacturing corporation, and to issue bonds to raise the money to pay for such subscription, and to levy taxes for the payment of the principal and interest on said bonds. (Weismer *vs.* Douglas, 64 N. Y., 91.) In a similar case (Sweet *vs.* Hurlbert, 51 Barber) Justice James expressed himself as follows:

> If this can be done, it is legal robbery; less respectable than highway robbery in this, that the perpetrator of the latter assumes the danger and infamy of the act, where this act has the shield of legislative irresponsibility.

In Cole *vs.* La Grange (113 U. S.), the case turned on an act of the Legislature of Missouri authorizing the city of La Grange, whenever two thirds of the resident taxpayers signified their approval at a special election, to levy a tax not exceeding two per cent per annum on the assessed value of the real and personal property in the city, to pay for a donation or subscription to the stock of a manufacturing company. The court held the act void; the opinion, written by Mr. Justice Gray, embodying the following language:

> The general grant of legislative power in the Constitution of the State does not enable the Legislature, in the exercise either of the right of eminent domain or of the right of taxation, to authorize counties, cities, or towns to contract, for private objects, debts which must be paid by taxes.

It can not, therefore, authorize them to issue bonds to assist merchants or manufacturers, whether natural persons or corporations, in their private business. These limits of the legislative power are now too firmly established by judicial decisions to require extended argument upon the subject.

In Burlington *vs.* Beasley (94 U. S., 310), however, taxation in aid of a public gristmill, the tolls of which the Legislature would have a right to regulate, was sustained; the construction of such a mill in a new country being probably a public necessity, and not possible without public aid.

But perhaps the most weighty opinion on this question is that of the United States Supreme Court in the case of the Loan Association *vs.* Topeka, 20 Wall, 655 (before referred to on page 153, vol. L., Popular Science Monthly). In 1872 the Legislature of Kansas passed an act authorizing cities and counties to issue bonds for the purpose of encouraging the establishment of manufactures and other like enterprises; and under this act the city of Topeka created and issued its bonds, to the extent of $100,000, and gave the same "as a donation," a majority of voters approving, to an iron-bridge company, as a consideration for establishing and operating their shops within the limits of the city. The interest coupons first due on these bonds were promptly paid by the city out of a fund raised by taxation for that purpose, but subsequently, when the second coupons became due, and the bonds had passed out of the possession of the bridge company by *bona fide* sale to a loan association, the city meanly repudiated its obligations, on the ground that the Legislature of Kansas had no authority under the Constitution of the State to authorize the issue of bonds, the interest and principal of which were to be paid from the proceeds of taxes, for any such purpose as the encouragement of manufacturing enterprises. Legal proceedings to enforce payment were thereupon commenced by the bondholders in the United States Circuit Court, and judgment having been there given for the city, the case was appealed to the United States Supreme Court, where with only one dissenting voice (Judge Clifford) the judgment of the lower court was affirmed.

The following extracts from the opinion of the court, given by Justice Miller, will forever stand as embodying economic and legal principles of the highest importance:

"Beyond a cavil there can be no lawful tax which is not laid for a public purpose. . . . It may not be easy to draw the line in all cases so as to decide what is a public purpose in this sense and what is not. But in the case before us, in which towns are authorized to contribute aid by way of taxation to any class of manufactures, there is no difficulty in holding that this is not such a public purpose as we have been considering. If it be said that a benefit results to the local public of a town by establishing manufac-

tures, the same may be said of any other business or pursuit which employs capital or labor. The merchant, the mechanic, the innkeeper, the banker, the builder, the steamboat owner, are equally promoters of the public good, and equally deserving the aid of the citizens by forced contributions. No line can be drawn in favor of the manufacturer which would not open the public treasury to the importunities of two thirds of the business men of the city or town." *

Twelve years later a similar case was decided by the same United States Court in the same way. Under the authority of a State law, the city of Parkersburg, Virginia, had issued bonds in aid of a private enterprise. The court decided these bonds to be void for the reasons set forth in Loan Association *vs.* Topeka. The decision was rested wholly upon the decision in the earlier case, and there was no dissent from it, although one justice (Clifford) had dissented in the Topeka case. Justice Blatchford, in rendering the opinion, said: "Taxation to pay the bonds in question is not taxation for a public object. It is taxation which takes the

* Here, then, we have from the Supreme Court of the United States a decision, as recent as October, 1874, defining the limitation of the power of taxation growing out of "the essential nature of a free government"; and if under such natural limitation there is no power, as the court decided, in a State government (irrespective of anything to the contrary in the Constitution of such State) to levy taxes for the support or encouragement of manufacturers, it is difficult to see under what rule or authority the Federal Government can levy taxes like those now imposed, which, from the circumstance that they yield year after year little or no revenue to the national Treasury, are manifestly levied and maintained for other than public purposes.

Whether, if a case involving the validity of tariff taxes like those above specified could be brought before the United States Supreme Court, it would apply the same rule of principle to the Federal that it has to a State government, in respect to the limitation of the sphere of taxation, may be regarded as an open question. An opportunity for avoiding a decision on this subject might be found in the assumption that there was no evidence before the court that any particular tariff act was passed by Congress for any other than revenue purposes, and that the court could not take cognizance of a subsequent change in circumstances growing out of changes in the conditions of prices and supply and demand. And in this connection it is curious to note that in the first tariff enactments of the Federal Congress, which embodied the principle of protection, the preambles of the act openly stated and recognized the objects aimed at, viz., "the support of the Government, and the encouragement and protection of manufactures"; while in later years the latter clause, relative to manufactures, has been shrewdly omitted from the tariff act preambles—possibly from a suspicion that there was a constitutional question covered up in this matter of protective duties which some day would not be found able to stand judicial examination.

But until the contrary is proved, the opinions and judgment of the Supreme Court of the United States, as given in the Topeka case, would seem to admit of no other construction than that taxation for any other purpose than revenue, or taxation for protection, or in aid of private interests engaged in manufacturing, is beyond the province of the legislative power of either our national or State governments, and when imposed—to use the exact language of the court—"is none the less robbery because it is done under the forms of law and is called taxation."

private property of one person for the private use of another person."

Particular care has also been taken by the Courts to close the door against the possibility of making taxation subservient to any private purpose by incorporating it with some public purpose:

> Public aid to private purposes can not be secured by yoking them to a public purpose. And where the public and private purposes are attempted to be aided by a single concession, the latter vitiate rather than the former uphold the grant. The entire purpose—or, if there are several, and no rule of apportionment as to the application of the proceeds—then all the purposes must be public.—*Opinion of Justice Brewer, 23 Kansas, 745.*

The cases in which the above conclusions have been apparently antagonized before the courts of the United States have been numerous, and have related mainly to the right of the Legislatures of the several States to levy taxes for purposes in respect to which the paramount object—i. e., for public or private good—was not clearly evident; as for the construction of railroads, the drainage of land, the promotion of sanitary measures, the payment of bounties in aid of educational or charitable institutions whose property is owned by and whose policy is directed by private individuals, religious sects, or corporations, and not by the State, and the like.

The question whether taxation by which aid was afforded by towns or counties to the building of railroads was for a public purpose, has been especially brought to the attention of the courts, State and Federal, in repeated instances; and, although the preponderance of opinion has been in the affirmative when legislative authority has been previously granted, yet the decision of the courts has rarely been unanimous, and in some cases has been adverse. Thus, in People *vs.* Township (20 Michigan, 452), an act of the Legislature of Michigan authorizing townships to pledge their credit to aid in the construction of a railroad from the city of Detroit to a suburban village was held void in a remarkably able opinion by Justice Cooley. Again, in Whiting *vs.* Sheboygan (25 Wisconsin, 157), an act of the Legislature of Wisconsin authorizing the county of Fond du Lac to levy a tax, the proceeds of which were to be given to aid the building of a railroad from the city of Fond du Lac to the city of Ripon, was also held by the court to be void.

The argument in favor of the unconstitutionality or wrongfulness of the application of the proceeds of the taxation of the people by States or municipalities for aiding the construction of railroads has been, that they are built by corporations organized mainly for the purpose of gain; that they are under the control of such corporations rather than that of the State; and that the taxes in question went to swell the profits of individuals, and did

not result in good to the State or benefit to the public except in a remote collateral way.

On the other hand, it has been urged that roads, canals, bridges, navigable streams, and all other highways, have in all times been matters of public concern; that such channels of travel and of the carrying business have always been established, improved, and regulated by the State; and that a railroad had not lost this character because constructed by individual enterprise, aggregated into a corporation.

In rendering an opinion in the celebrated Loan Association *vs.* Topeka case, the court took up the question whether the grants of public money or credit which have been made by counties and municipalities in the United States in aid of railroad construction were not by parity of reasoning equally unconstitutional as similar grants for establishing or encouraging manufactures have been held to be; and remarked that in all such cases, which have been numerous before the courts in every State in the Union, "the decision has turned upon the question whether the taxation by which the aid was afforded to the building of railroads was for a public purpose. Those of the judges who came to the conclusion that it was, held the law for that purpose valid. Those who could not reach that conclusion held them void. And it is safe to say that no court has held debts created in aid of railroad companies, by counties or towns, valid on any other ground than that the purpose for which the tax was levied was a public use, a purpose or object which it was the right and the duty of the State governments to assist by money raised from the people by taxation." But, continues the judge, "*Of the disastrous consequences which have followed its recognition by the courts, and which were predicted when it was first established, there can be no doubt.*"

It is interesting to note in this connection that since the decision in this case many States of the Union have been forced to prohibit loans in aid of the construction of railroads and like enterprises in the revision of their Constitutionss.

When the purpose of taxation is evidently to primarily promote the interests of individuals—i. e., to establish a manufactory, a brick company, a hotel, and the like—the courts whose province it is to decide whether the purpose is public or private will as a rule undoubtedly declare it void.

A noted and the almost solitary instance in which the above proposition and precedents have been clearly antagonized by a judicial decision is to be found in a case in Louisiana, where an act of the State Legislature authorizing a municipal subscription to the stock of a company incorporated to build a theater was held valid, on the ground that "it would contribute to the wealth and embellishment of the city, afford a place of relaxation and amuse-

ment, and would tend to correct and enlighten the morals of the citizens." (First Municipality *vs.* New Orleans Theater Company, 2 Rob., Louisiana, 209.)

THE BOUNTY CASE OF 1891.—A review of this department of the application of taxation would be incomplete that failed to notice a legal contention before the Supreme Court of the United States in 1891, respecting the constitutionality of the tariff act of 1890, which was questioned on several grounds; one of them being a provision requiring the payment of bounties to every producer of sugar of certain saccharine strength * from beet, sorghum, sugar cane, or maple sap, grown or produced within the United States. Under this provision of the tariff enactment of 1890, the citizen of Connecticut was taxed for the benefit of the farmer of Nebraska or California, and the farmer of New York for the benefit of the Louisiana planter; the farmer who raised wheat and corn at ten or twelve dollars an acre was taxed for the benefit of a farmer in a distant State who raised sugar cane or sugar beets at fifty or a hundred dollars an acre. There was, moreover, but little doubt that the inclusion of sugar, made from maple sap, in the bounty provision, was not originally contemplated by the originators and promoters of the act; inasmuch as the manufacture of such sugar is one of the most profitable industries of the country, and as a rule readily calls for a fancy or artificial price; but was included in the act, while under consideration by Congress, for the reason that its enactment into law would otherwise have been difficult or impossible. Another interesting and anomalous feature of this case was that it originated in an attempt to obtain the bounty after the enactment (law) offering it was repealed, on the ground that the claimants planted cane in expectation of the continuance of the bounty, and would suffer loss if they did not get it. The question of the validity of the entire tariff act, by reason of the unconstitutionality of the bounty provision contained in it, having been raised, the attorney general of the United States antagonized such assumption before the court as follows:

First, that under the clause of the Federal Constitution (section 8 of Article I) which empowers Congress to levy taxes, duties, etc., "to pay the debts and provide for the general welfare" of the United States, Congress has the power to expend taxes for anything which, in its judgment, is "for the general welfare." Second, that the judicial decisions of the State courts, to the effect that taxation, to be lawful, must be for public purposes, have no application to this controversy, inasmuch as they were all of them

* Two cents per pound on sugar testing not less than 90° by the polariscope, and one and three fourths cents per pound on sugar testing less than 90°, but not less than 80°.

cases of municipal taxation, which must be for public municipal purposes; and that it is obvious that the establishment of a particular industry in one place, by a bonus to specified private individuals, is a very different object for taxation than the encouragement by the national Government of a widespread industry in many quarters of the Union for national purposes, with a view of diversifying the industries of the country and making it independent of other countries for its necessities." (*Speech of United States Attorney-General Miller.*) Third, that the assumption that "public purposes" in respect to taxation by Congress means something different than the same phrase when applied to State taxation is sustained by instances in which Congress has authorized the expenditure of public moneys for bounties or relief to people in this and other countries; some forty cases of this character being cited, in which relief in the form of money or supplies was given to sufferers by fire, grasshoppers, overflow of the Mississippi, yellow fever, earthquakes (one in Venezuela, South America), and for defraying the expense of transporting food to Ireland, France, and Germany. To these instances may perhaps be added the "codfish bounty," which was practically a drawback upon the duty on imported salt used for preserving fish.

In rejoinder it was contended: First, that if Congress has power to expend taxes for anything which in its judgment is "for the general welfare," then there is practically no limitation whatever upon its constitutional power to raise and appropriate taxes; and that its power to treat the public purse as its own, and give away the proceeds of taxation is as unlimited as is the cupidity of congressional lobbyists. It was also ingeniously pointed out that the position of the attorney general was equivalent to saying that when a tax is levied by a State for a given purpose it is not for public use, but when levied by the national Government for the same or a like purpose it is for public use. Again, such an assumption of unlimited power on the part of Congress directly antagonizes the opinions of Chief-Justice Marshall (see page 149, vol. L, Popular Science Monthly) and also the declaration, made in special reference to the taxing power by the United States Supreme Court through Mr. Justice Miller in the Topeka case (page 153, ditto), "*That the theory of our governments, State and national, is opposed to* the deposit of unlimited power anywhere." Justice Story (on the Constitution, section 990) also asks and answers the precise question at issue: "Has Congress a right to raise and appropriate the public money to any and to every purpose according to their will and pleasure? *They certainly have not.*" The same jurist, in his lectures on the Constitution, thus further amplified his ideas on this subject, and evidently thought that he had in the following brief paragraphs

brought the argument in support of the "unlimited" theory to a *reductio ad absurdum:*

"A power to lay taxes for the common defense and general welfare of the United States is not in common sense a general power." It is "a power exclusively given to raise revenue, and it can constitutionally be applied to no other purpose. The application for other purposes is an abuse of the power; and in fact, however it may be in form disguised, is a premeditated usurpation of authority." A grant under the Constitution to Congress "to do any act they pleased which ought to be for the good of the Union . . . would reduce the whole instrument to a single phase, that of instituting a Congress with power to do whatever would be for the good of the United States; and as they would be the sole judges of good or evil, it would also be a power to do whatever evil they pleased" (1 Story, Constitution, section 926).

Second, to the assumption that the decisions of the State courts in respect to the limitations of the power of taxation do not apply to this controversy, it was replied that the relation of the State courts to their State Constitutions is substantially the same as that existing between the Federal Supreme Court and Congress; that the State decisions (which have not been, as was claimed, "all cases of municipal taxation") frequently treat such legislation, independently of Constitutions, as being in violation of natural right, and that there are limitations imposed upon legislative power by reason of "general principles" has been recognized by the United States Supreme Court (Bartemeyer *vs.* Iowa, 12 Wallace). It would further seem that natural rights must be the same, whether against legislation by Congress or by the Legislature of a State. If a State can not levy and expend taxes for other than public purposes, it may be presumed, *a fortiori,* that the national Government can not, "for the former can do *anything* which the Constitution (and natural right) do not forbid; while the latter can do nothing which the Constitution does not first sanction." The Federal Government has "no right to raise money by taxation for a thousand things for which the State may impose taxes and collect them of the people" (Miller, Justice, Lectures on the Constitution).

Third, in respect to the instances cited, in which Congress has expended moneys for bounties, or relief of private interests, in this and other countries, it was replied that they were all matters of national charity; were never subjected to judicial scrutiny, or even seriously challenged in debate; were never for large amounts, and did not contemplate any special levy of taxes, but were from funds already in the Treasury. It was also claimed that this was the first case in which the constitutionality of a congressional bounty, whether direct or indirect, for "protection," has ever been

before the United States Supreme Court for discussion. And pertinent to the case it should be further noted, that when it was proposed in the Convention that framed the Federal Constitution to incorporate in it a provision for bestowing "rewards" for "the promotion of agriculture," the proposition was rejected.

The facts about the bounty for codfisheries are, that it was given under the first revenue laws (levying duties) of the United States in 1792, and was intended to offset bounties and other measures adopted by England, as was believed, for the purpose of destroying the fisheries, not only of the United States, but also of France. Its enactment was strenuously resisted at the time, on constitutional grounds, and especially by as good a constitutional authority as Madison, who held that the enactment of a bounty was beyond the power of Congress (4 Elliot's Debates, Philadelphia edition, 1875, 525, 526). Its legality was never judicially examined, and the act expired by its own limitation in seven years. Subsequent acts expressing limitation were passed of the same character from time to time; and since their final expiration, many years ago, it is claimed that no Congress, until the Fifty-ninth, 1890, has asserted its right to levy taxation embodying the bounty principle.

The court, in giving an opinion affirming the constitutionality of the tariff act of 1890, evaded the question of the constitutionality of its bounty provision, on the ground that the invalidity of one part of a revenue act does not invalidate the whole act; and when that principle was settled, the objections to the act based on separate clauses really disappeared.*

The disbursement of the money voted by Congress for the payment of the sugar bounties having been withheld by the Comptroller of the United States Treasury on the ground that the appropriation was unconstitutional, the court held that if Congress made promises and thereby induced people to incur expenses which they would not otherwise have incurred, and has then appropriated the money to indemnify the parties, the payment can not be stopped by an administrative officer on the ground of the unconstitutionality of the primary bounty enactment.

A question of interest in connection with this case, which may naturally suggest itself, especially to those not learned in the law, is, How happens it that repeated acts of expenditure of money raised by taxation for admittedly private purposes have been

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* One of the best reviews of this celebrated case, one to which the writer has been greatly indebted, is to be found in an article contributed to and published in the Harvard Law Review for February, 1892, by Charles B. Chamberlain, Esq., of Boston.

authorized by Congress, without any challenge before the proper courts of their constitutionality? The answer is to be found in the legal fact that "the question of the constitutionality of a law can never be presented and determined abstractly. It must always be raised by somebody whose person or property is affected by the execution of the statute the validity of which he impugns.* Until the opportunity for raising and the individual who can raise the question of constitutionality present themselves, there can be no presumption from the existence of such legislation upon the statutebook."

In Maine, a law which for more than half a century—almost as long as the State has existed—had been enforced, and reproduced in each revision of the statutes, was declared unconstitutional so soon as challenged; the chief justice meeting the reason for such acquiescence by saying that "the judicial opinion and the public sense were not so much awakened to the principle underlying this then as now." (Brief of Smith and Clarke, averring the unconstitutionality of the tariff act of 1890.) *

The nature, definition, and limitations of the service for public purposes, which a free representative government can render or perform by the expenditure of moneys raised by taxation having been once ascertained and enunciated by the supreme judicial authority of the State (as would seem to have been done in the United States), the instant, thereafter, that taxation essays to become anything but taxation—i. e., for an unquestionable public purpose; the instant that it is made an instrumentality for effecting any results other than such as are directly necessary or beneficial to the whole public, that instant it becomes inequitable and antagonistic to the very idea of a just government; and the citizen whose person or property is thereby affected has at least a moral right to demand protection and redress.

[*To be continued.*]

ACCORDING to Mr. Meredith Nugent, in Our Animal Friends, elephants like fun. Two little elephants at Bridgeport, he says, take evident pleasure in the tasks that are set them. Even in the stable, when no trainer was about, one of them "would stand on its head just as it was used to do in the circus, and the other would look anxiously on until its own turn came to stand on its head and be admired by its companion."

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* "It is by facts and instances that the people are taught their Constitutions and their laws. Constitutions are framed; laws established; institutions built up; the processes of society go on, until at length, by some opposing, some competing, some contending forces of the State, an individual is brought into the point of collision, and the clouds surcharged with the great force of the public welfare burst over his head."—*Speech of Mr. Evarts for the Defense, in the Impeachment of President Johnson.*

"CONFESSIONS" OF A NORMAL-SCHOOL TEACHER.

By MARY HALL LEONARD.

IN this age of frank subjective expression when we are taken into the confidence of so many interesting personalities, when authors write their "reminiscences" or recall their "literary passions," when men of business recount the steps by which they climbed the ladder of success, and when even the public-school teachers have found a welcome for their "confessions" in the literary magazines, it seems good to me also, having been a normal-school teacher from the first (that is, having spent most of the years since, a girl in my teens, I graduated at a State normal school, in teaching in similar institutions of different sections of the country), to set forth in order a few of the things that are surely believed by the members of our craft.

It is currently reported that we normal-school people are not an erudite class; that there are many things in the philosophies of heaven and earth that are not included in the horizon of our mental vision. Indeed, we have heard this so many times that it begins to seem like a "chestnut" to our indurated ears. Brethren of the college and out of the college, when next you feel moved to characterize our mental status, please tell us something new.

As to the charge itself we have no desire to enter into controversy regarding it. We have a high respect for knowledge, especially of the *real* kind. We prefer this to the sort possessed by a certain fabled princess of one of Henry James's novels, who had been told all the facts in the universe, but had never in her life perceived anything. For this latter kind of "knowledge" we are not perhaps so greedy as some, while recognizing that "information" also has its value and uses.

But we confess, jointly and severally, to a measure of truth in the indictment. There are halls in the temple of knowledge where the feet of some of us have never trod; there are shrines at which some of us have never worshiped. Friend Critic, forgive us if we sometimes question whether you yourself have tasted of every "apple" that grows upon the tree of knowledge, unless by proxy as it were, after the manner of the fabled princess aforesaid.

We are inclined to the belief that native ability and persistent effort have more to do with the acquisition of mental power than the question of what seat of learning one studies in. Much that a student thinks he learns while acquiring a so-called "education" is only "skin-deep," and has little appreciable effect upon the after-efforts of life. But if a mind of good ability has learned how to study, and has a strong desire for improvement and is ex-

pending its energies upon worthy subjects of thought, it is difficult to see how the results of a given period of study—whether two, four, or ten years, or a whole lifetime—could be very unequal in the total sum, whether these years be passed in the normal school, or in the college, or in one's own well-furnished library, or in a pioneer's cabin with only a few "best" books that are pored over and pondered till they become part of one's very life. Not that the results would be alike in the several cases. Far from it. But all disabilities have their compensations; and perhaps the total gain for a like amount of effort may not vary so much as is sometimes supposed.

For my own school education—to make a more personal "confession"—I had a desire for the seminary course that some of my young friends entered upon (it was before the days of the multiplication of women's colleges); but, in reviewing the results of school life after the lapse of years, I see no reason to blame the dispensation of Providence, which, by making me one of a large family of children, caused the financial straitness that sent me to a normal school instead. The normal school taught me how to study and deepened the desire for study that I already possessed. Even if the school had done nothing else, it would have deserved my lasting gratitude.

But it did other things for me. It opened before me a definite line of work worthy of my best endeavors. It gave me a practical touch with some of the phases of school work and saved me from some of the crudities and mistakes that hamper a young teacher's efforts. It did not save me from all such mistakes. It has been truly said, "No matter what the training, every teacher needs experience." But I am sure that the normal school gave me some aids to my work as a teacher that I should not have been likely to receive in any other kind of school.

There is one view of the relation of normal-school graduates to the teaching profession that may be illustrated by the following incident: A young lady, after graduating at a high school, took the classical or four years' course at a New England normal school, and afterward taught successfully for twelve years in the high schools of Massachusetts. Then came family changes, followed by a period of enforced rest. When she was able to resume her profession she first took a year of special study in a private institution of high reputation, without remaining long enough, however, to receive the diploma of the "college."

She then proposed to enroll herself in the leading teachers' agencies as a candidate for a high-school position. But she was met with the statement: "It is not easy for a teacher to obtain a high-school engagement unless she is a college graduate. Let us advise you to turn your attention to school supervision, or to the

kindergarten, or to some form of work connected with the lower grades of schools."

"But," said the teacher, "I do not feel ready for those other lines of work. My teaching has always been in high schools, and this is what I can do best."

"We do not doubt," was the reply, "that you can do better teaching in high schools than most of those who apply. Nevertheless, we have to cater to the demand."

"But there are a great many normal-school graduates in the high schools, to my certain knowledge."

"Oh, yes; the normal-school graduates who are in that work do not lose their positions. But women's colleges are in the mind of the public now, and an application for a high-school teacher usually specifies that one of their graduates is wanted."

Without pausing to suggest that the conceded fact that the normal-school graduates retain their high-school positions argued something regarding their ability to fill them, the teacher continued: "I should think the training and experience that I have had ought certainly to count for as much as the college course."

"Yes. It is really worth much more; but it is the name that is chiefly desired. School men are not satisfied with knowing that a teacher has had a collegiate training. They want the full college *degree*. The other day we recommended a young lady who has just graduated from —— College, ranking second in her class. The superintendent, after making a note of the fact, remarked, 'How finely that will sound in my report to the school board and in the advertisements of the school!'"

We are conscious of no acerbity or envious cravings on account of the academic degrees and honors of the universities. We appreciate that a real value attaches to such marks of recognized attainment when honestly bestowed, and held with no exaggerated sense of their importance. So also the titles of nobility, heraldic insignia, and military decorations of the Old World are of value, unless they have become divorced from the sentiments which gave them birth.

But, as self-respecting Americans, we do not wish to feel ourselves dependent upon such factitious means for success in life. Nor do we feel so. We call to mind that the greatest American of this half century was "graduated" from school life after a few months' study in a backwoods school. When he came to the highest position of responsibility ever held by a citizen of the United States, it was said by a distinguished college president, "Lincoln may have good sense, but he will need some one to write his messages for him." Yet the two great classic prose utterances of the war period are Lincoln's Emancipation Proclamation and his Gettysburg address.

As we mingle freely and on equal terms with our friends and kinsfolk and acquaintance who are among the Ph. D.'s and LL. D.'s and D. D.'s of scholarly fame, and also with the younger sisterhood of educated women who are wearing recent college honors, we are sensible of no feeling of abashed inferiority, as though in the presence of things too high for us; nor do the attainments of these scholars, which we appreciate and greatly rejoice in, seem to dwarf in any degree the apparently equally valuable powers of many another friend whose mental acquirements have been gained in some widely different course of training in the great university of American life.

But there is something in the experience of that high-school teacher with the agencies which raises a query as to the relations of the high schools to the educational status of the modern age. If there is one point that seems fully proved by the educational progress of the last half century it is that kindergarten and primary-school teachers need professional training for their work. The time was, and not so very long ago, when it was thought that any one with a common-school education could teach little children. But it seems a far cry back to that position to-day.

Is it, then, true that the high school is the only part of our public-school system in which the teacher does not need to be a student of pedagogical science, to be in sympathetic and intelligent touch with modern school methods, and to have gained a degree of tried skill through supervised schoolroom experience before being placed in full charge of schoolroom work? This would indeed be passing strange. One would suppose that the high-school teacher must need for his equipment an intelligent understanding of the methods and plans of the lower schools from the kindergarten up, with some added study of the special needs of high schools—a more comprehensive rather than a shorter course of professional training. If not, then will some one tell us why not?

The question is not whether the high-school teacher should have a broad and thorough scholarship. That "goes without saying." And if it be said that the best place to gain this scholarship is within the walls of a good college, we of the normal school have no desire to challenge the assertion. But, given all that scholarship, all that native ability can do, the idea that high-school teachers have less need than primary teachers to professionalize their work is a baseless assumption which is certain to be undermined sooner or later by the tide of educational progress. It is not hard to predict that the near future will require of the would-be high-school teacher as much of scholarship as the college gives, and as much professional equipment as is given by the normal schools in their best and longest courses.

As to how and in what kind of schools this double equipment can best be given—ah! that is another question, beyond the limits of this paper to discuss, and, like all questions that deal with expedients, hard to settle—differing minds will always prefer differing expedients for the same end.

Will the professional training be included in the college curriculum? Has any college yet provided for it? I mean, not simply by a course of lectures on Herbartian Philosophy, but also by a close and vital study of all the conditions of public-school work. It is a healthy sign of the times that the colleges are addressing themselves to pedagogical questions. The combined efforts of all the institutions of learning will be none too effective for the work of public education. But all real aid to public schools must be given in the spirit of those who would build up rather than pull down, who can distinguish in the work of others a right ideal in the midst of the crowding obstacles that prevent the full realization of that ideal, and who do not hold themselves aloof from personal labor as mutual helpers and learners with other earnest and open-minded thinkers who are already carrying the burdens of the work.

Can the normal schools give this double preparation for high-school work, providing the requisite scholarship as well as the practical and professional training? If it be true that they have not heretofore done so, perhaps the importance of the work they have been doing for the elementary schools offers a partial explanation. But it would be a matter of public interest if educationists should really inquire and find out how nearly the best normal schools in their four years' courses reach the standard of the colleges in scholastic attainments, and also how much difficulty there would be in superadding to these courses whatever they may now lack of such attainments. It would certainly seem to be feasible for a State system of public instruction to prepare at least some of the teachers needed for all grades of its own work. To delegate the work for the higher grades entirely to private institutions which have no practical relations with the lower-grade work, would be to establish a break in the public-school system that it would be hard to justify.

But here again the experience of that high-school teacher raises a question. It would almost seem that in the minds of the managers of the agencies such a breach is known to exist; that while the lower schools belong to the masses of the people, the high school is supposed to be intended primarily as a feeder for the colleges, so that to introduce any other than a collegiate element into its teaching force suggests a "poaching upon the college preserves." There is more than a suspicion abroad that the high schools do stand in just this position of uncertainty, whether

their work is chiefly that of a college preparatory school, or whether they are also the head and crown of the school system in which the child of the people finds his best school preparation for whatever career his future may hold. To sustain this double responsibility is more than the high school can do, unless perchance the colleges and the elementary schools can be so brought into harmony—by the modification of one or the other or both—that fitting for college and for general American citizenship shall become one and the same thing.

That the high-school course ought to lead to the door of the college was the unanimous verdict of the able committee whose Report on Secondary Schools has become so famous. But if this be interpreted as meaning that the colleges alone can set the pace for high-school instruction, or if the influence of that report should be to separate the high school from the lower schools, both in its aim and the *personnel* of its teaching force, then, indeed, it is certain that time must bring a reaction. There can be no fundamental reason for an explicit change of policy in the public-school work at the end of the ninth grade.

Since the high schools must sustain such intimate relations with colleges and lower schools, with public and private institutions, it would seem to be the necessary policy of their managers to keep them in fullest touch with both of the leading schools of current educational thought. And here we come face to face with what is perhaps the bottom fact in the situation. It must be confessed that in the educational world there are two types of thinking and thinkers, neither of them confined in its affiliations to the college or to the elementary schools, yet each having its own peculiar relations both with the one and with the other. The one type represents time-honored ideals, it may be of scholarship and culture, or it may be of practical forms and methods—ideals which experience has wrought out, and which are therefore held to be worthy of acceptance. The other type seeks to build up an improved system of education according to principles that are held to be fundamental; and, believing that "new wine must be put into new bottles," it does not scruple to turn aside, if occasion arises, from the standards of the past.

Nor is this true of education alone. It is the same in politics, in religion, in literature, and in every form of art. The traditional or conventional ideals coexist side by side with a newer philosophy, which seems antagonistic until a later view unites them both in its larger perspective.

In the educational world within two or three years these types in a measure seem to have focused themselves in two famous documents, the report of the Committee of Ten on Secondary Schools, and the later report of the Committee of Fifteen—or, as

is sometimes said, the Committee of Five, since it is the report of one third of the committee—on the Correlation of Primary Studies, that has become most noted. Though these are ostensibly on different subjects, the report on secondary schools could not fail to take into account the previous school training, nor could the primary work be reported without a long look forward.

Both reports aim at progressive effort for the improvement of the lower schools, and are valuable contributions to the educational literature of the age. The specific suggestions of the two apparently differ less than the guiding principles that seem to have moved the committees. For, consciously or unconsciously, the one seems to have the eye fixed upon certain established ideals of culture and scholarship which are held as the standards for the colleges, and hence, it is assumed, must be the goal of effort for the lower schools. In the other report we seem to hear the note of a different philosophy—a reaching forward toward all the possible activities of the child's future. Yet in this also there is an ideal which beckons onward; but it is not found in traditional types. It is based on the complex needs of our great American life—to prepare the child to understand and to meet those needs and to direct the forces of the future.

If it be said that the collegiate standards are shaped according to the same ideal, the answer must be: Perhaps so; yet the American people will not accept their standards at second hand, or as established for them by a single class in the community. In determining their own educational needs, the great middle class of the people is also in the jury box. The schools that are "for the people" must be planned in a good degree "by the people," instead of following wholly the lead of the highly educated few.

There is a time-honored maxim of the universities that educational influences proceed from the top downward. But, like all epigrams, it is a brilliant half-truth. There is no "top" to education, or if there be it is higher than all human standards, reaching into the very heavens. And this is a ladder over which the angels must pass both ways, ascending and descending upon it. The way must be kept open, and the touch must be free all along the line. There must be no dividing gap where either type of thought can say to the other, "Thus far shalt thou go and no farther." Especially in the high school should there be the largest welcome to good influences from either side. Then the one that can show the largest sympathy and most intelligent understanding of the whole problem will have the greatest influence in the final shaping of affairs.

Yet even as I write a growing doubt arises. Is there really any such conflict in the forces that move educational affairs as we sometimes think? Or, if there be, is it wholly to be depre-

cated? We know that friction of opinion is the pioneer's axe that clears the path for progress. And whichever side of a question we may find ourselves upon, we should not forget that "the strong opposition is the balancewheel of all parliaments," in the educational as well as the civic world.

But is there really a gap in our educational system? The "bloody chasm" that a few years ago divided two great sections of our country seems to have been chiefly an abstract entity after all. Whenever individuals met in human relations they usually forgot that it had ever yawned between them. We seem to see a multitude of teachers ranged in two great ranks. But their hands are constantly reaching out toward each other in friendly aid, and there is therefore no gap between them, scarcely a dividing line. Collegiate schools are studying the problems of childhood, and normal and public school teachers have no intention to rest satisfied with feeble results in the first of their trinity of aims—knowledge, power, and skill. The faces of the teachers may be turned toward different parts of the horizon; but when we lift our eyes upward we are looking into the same boundless sphere of truth and of life, whose mysteries we are all trying to discover and interpret.

But in a personal "confession" one should not wander into mazes of rhetoric and philosophy. Coming back to my personal bearings, I am strongly reminded of an American gentleman who took an extended tour in Europe. After some months of travel, being a good Christian as well as a tourist, he wrote home to America: "I have discovered that there are just two religious denominations, the prayer-book denomination and that of the prayer-*meeting*. The more I see of each, the more I recognize that I have a genuine sympathy with both. I can worship with pleasure and with profit in 'churches' and in 'chapels.' But when it comes to Christian work I feel that, however it may be with others, I myself can find my best field for endeavor in the prayer-meeting denomination."

It is with a feeling akin to his that I write: I have much fellow-feeling with both "denominations" of educational thought; yet I do not regret that the circumstances of my life have fixed my lines of work more especially with the "denomination" that is in closest touch with the masses of the American people.

His object being the systematic exploration of the Franz-Josef Archipelago and the unknown seas adjacent, Mr. Harmsworth, it is announced, intends to keep an expedition in the arctic regions till a complete map can be made of all accessible parts of the still undiscovered north polar world. The Jackson-Harmsworth Expedition is spending its third winter in the arctic regions, and will make another advance in the coming season.

THE MALARIAL PARASITE AND OTHER PATHOGENIC PROTOZOA.*

By GEORGE M. STERNBERG, M. D., LL. D.,
SURGEON GENERAL, UNITED STATES ARMY.

GENTLEMEN: My presidential address last year had for its subject The Practical Results of Bacteriological Researches, and at its conclusion I showed you upon the screen photomicrographs of the principal pathogenic bacteria, including the micrococcus of pneumonia; the micrococci concerned in the production of boils, abscesses, wound infection, puerperal fever, erysipelas, etc.; the bacilli of tuberculosis, of diphtheria, of typhoid fever, of glanders, of anthrax, of influenza, of tetanus, of leprosy; the spirillum of relapsing fever, the spirillum of Asiatic cholera, and various other pathogenic bacteria. These micro-organisms are now generally recognized as belonging to the vegetable kingdom, and as a specialist in this department of scientific investigation your president may perhaps be considered a botanist *in a small way*. But the Biological Society includes among its members many distinguished specialists in that branch of natural history which relates to the animal kingdom, and I think it due to the zoölogists to show that the botanists have no monopoly of mischief-making micro-organisms. In speaking of the pathogenic protozoa I shall devote special attention to the hæmatozoon which is now recognized as the specific cause of the malarial fevers; and in consideration of the importance of this blood parasite from a sanitary point of view, as well as of the interest which attaches to it from a biological standpoint, I shall occupy a little time in giving you an account of its discovery and the grounds upon which it is accepted by well-informed pathologists as the specific infectious agent in the class of fevers referred to.

The malarial parasite was discovered in 1880 by Laveran, a surgeon in the French army, at that time stationed in Algeria, but now a professor in the military school at Val de Grâce.

In my work on Malaria and Malarial Diseases, published in 1884, I refer to Laveran's alleged discovery as follows:

"According to this observer, there are found in the blood of patients attacked with malarial fever pigmented parasitic elements which present themselves under three principal aspects. This parasite is said to be a kind of animalcule which exists at first in an encysted state. In the blood these organisms present themselves as motionless, cylindrical, curved bodies, which are

* Presidential Address delivered before the Biological Society of Washington, December 5, 1896.

pointed and transparent and have a pigment spot; also as spherical bodies, about the diameter of a red blood-corpuscle, showing active movements and containing in their interior numerous pigment granules. The movements of these bodies are due to the action of elongated filaments attached to their circumference—flagella. A third form in which these parasites present themselves in the blood is as motionless, spherical, or irregular-shaped bodies containing dark-red, rounded pigment grains. These bodies have no nucleus, and do not stain with carmine; they appear to be the ultimate stage of development of the above.

"The blood also contains free pigment granules, pigmented leucocytes, and vacuolated red corpuscles which contain pigment granules.

"These parasitic elements have only been found in the blood of persons sick with malarial fever, and they disappear when quinine is administered.

"They are of the same nature as the pigmented bodies which exist in great numbers in the vessels and organs of patients dead with pernicious fever, which have been described as melanotic leucocytes. Laveran, at the time his report was published, had found these bodies in one hundred and eighty out of one hundred and ninety-two persons examined in Algeria and in Tunis who were affected with various symptoms of malarial poisoning.

"The presence of the parasite described by Laveran in the blood of persons suffering from malarial diseases is confirmed by Richard, who has studied the subject at Philippeville, France, where malarial diseases abound. This author has invariably found the parasite of Laveran in the blood of malarial-fever patients, and has never seen it in the blood of persons suffering from other diseases. He finds that its special habitat in the blood is the red corpuscles, in which it develops and which it leaves when it has reached maturity. During the attack of fever many blood globules are seen which possess a small, perfectly round spot. Otherwise they preserve their normal appearance; they are simply, so to speak, stung (*piqués*). Beside these globules are others in which the evolution of the microbe is more advanced. The clear spot is larger and is surrounded by fine black granules. The surrounding hæmoglobin forms a ring which decreases as the parasite augments in volume. After a time only a narrow, colorless zone remains at the margin. This corresponds with the body No. 2 of Laveran, 'having about the dimensions of a red corpuscle and inclosing an elegant collarette of black granules.' This collarette is the microbe which has arrived at its perfect state, and which is provided with one or several slender prolongations, measuring twenty-five micromillimetres or more in

length. Richard has several times seen the fully developed parasite emerge from its 'shell'—the remnant of the invaded red corpuscle—to which it may remain attached, and which can only be seen with great difficulty. Sometimes only the motile filaments penetrate the envelope in which the body of the parasite remains inclosed. In both cases the filament is seen to undergo active movements, and when its extremity is caught in the fibrinous reticulum the body itself oscillates. This movement may last for an hour. Usually, however, no movement is observed, and the corpuscles containing very small parasites never move. The infected corpuscles become disorganized, the pigmentary collarette is broken down, and a grayish mass inclosing some black granules remains. The pigment granules when set free are rapidly picked up by the leucocytes; the melaniferous leucocytes are therefore epiphenomena."

Commenting upon the observations of Laveran and Richard, I say, in the work just referred to:

"We can not doubt that a true account has been given of what the observers believe they have seen. But there is a wide field for doubt as to the deductions made from the various observations recorded; for in microscopical studies of the blood made with high powers there is a great liability to error and to misinterpretation of what is seen. We may question, for example, whether the belief of Laveran and Richard that the appearances noted by them are due to parasitic invasion of the blood-corpuscles is well founded, without calling in question the accuracy of their observations."

At the time this was written pathologists generally were not disposed to attach much importance to the alleged discovery of Laveran, and this was especially true in Germany and in those countries in which physicians were in the habit of awaiting the verdict of German bacteriologists before accepting a new "disease germ." One reason for this failure to give proper consideration to the discovery of Laveran was the fact that there was a rival in the field. A year before the publication of Laveran's paper, giving an account of his observations, the distinguished German pathologist Klebs, in association with the prominent Italian physician Tommasi-Crudeli, had announced the discovery of a bacillus which they believed to be the cause of the malarial fevers, and which they named *Bacillus malariæ*. Their experimental investigation was made in Rome with material obtained from the malarious marshes in the vicinity of that city.

The evidence offered in the original memoir of Klebs and Tommasi-Crudeli in favor of the view that the bacillus described by them is the cause of malarial fevers in man, is derived from experiments made upon rabbits, in which culture

fluids containing the bacillus in question, and washings from malarious soils, were injected subcutaneously.

In my work on Malaria and Malarial Diseases, already referred to (published in 1884), I say:

"The importance of this alleged discovery induced the National Board of Health, soon after the publication of the first report published by Klebs and Tommasi-Crudeli, to undertake control experiments in a recognized malarial locality in this country. The writer, who had established a laboratory in New Orleans for the purpose of studying the micro-organisms present in the atmosphere of that city, was therefore instructed to repeat the experiments of Klebs and Tommasi-Crudeli, and during the autumn of 1880 devoted a considerable portion of his time to this investigation. The results obtained were not favorable to the view that the fever produced in rabbits by the injection beneath their skin of infusions of swamp mud, etc., was a truly malarial fever; and, for reasons stated, the conclusion was reached that the evidence offered by Klebs and Tommasi-Crudeli in their first report, which alone had been published at this time, was unsatisfactory. (The full report of these investigations is given in Supplement No. 14, National Board of Health Bulletin, published in Washington, D. C., July 23, 1881.)"

Referring to subsequent observations, I remark:

"Since the publication of the report above referred to the belief that the *Bacillus malariæ* is the true cause of malarial fevers has received considerable support from observations made in Rome, under the direction of Tommasi-Crudeli, by Marchiafava, Cuboni, Peroncito, Ceri, and others.

"We do not feel prepared to estimate the value of this evidence in detail, but will, in a general way, give our reasons for considering it in a spirit of scientific skepticism, and for demanding substantial confirmation from other parts of the world where malarial fevers prevail, and especially in our own country, where malaria is so well known by its effects, and where the *Bacillus malariæ* should be easily found if it is constantly present in the blood during the cold stage of intermittents, as has been claimed by some of the Roman observers. . . .

"The writer's observations lead him to be very cautious in accepting evidence relating to the discovery of organisms in the blood, when these are few in number and require diligent search for their demonstration; for the possibilities of accidental contamination or of mistake in observation are very great. . . .

"The writer has many times examined carefully the blood of malarial-fever patients with a one-eighteenth-inch oil-immersion objective (of Zeiss), and has not been successful in finding either rods or spores. But few of these examinations have, however,

been made during the chill, and the blood has not been drawn directly from the spleen; these observations are therefore to be considered as incomplete, and, if opportunity offers, will be supplemented by more extended microscopical researches."

Notwithstanding this adverse criticism, based upon an experimental research made for the purpose of confirming the alleged discovery, if it should prove to have a scientific foundation, the *Bacillus malariæ* was pretty generally regarded by physicians in this country and in England as being the veritable cause of malarial fevers, and for several years it was frequently mentioned in medical journals and even in standard text-books of medicine as one of the demonstrated disease germs. But truth is mighty, and in the end must prevail. To-day no one speaks of the *Bacillus malariæ* of Klebs and Tommasi-Crudeli except to refer to it as one of the pseudo-discoveries, which for a time passed current, like a counterfeit coin, but which was detected and thrown aside when subjected to approved scientific tests.

The first confirmation in this country of Laveran's discovery of amœboid parasites in the blood of malarial-fever cases was made by the present writer in the pathological laboratory of the Johns Hopkins Hospital in March, 1886. In May, 1885, I had visited Rome as a delegate to the International Sanitary Conference convened in that city under the auspices of the Italian Government, and while there I visited the Santo Spirito Hospital for the purpose of witnessing a demonstration, by Drs. Marchiafava and Celli, of that city, of the presence of the *Plasmodium malariæ* in the blood of persons suffering from intermittent fever. Blood was drawn from the finger during the febrile attack and from individuals to whom quinine had not been administered. The demonstration was entirely satisfactory, and no doubt was left in my mind that I saw living parasitic micro-organisms in the interior of red blood-corpuscles obtained from the circulation of malarial-fever patients. The motions were quite slow, and were manifested by a gradual change of outline rather than by visible movement. After a period of amœboid activity of greater or less duration, the body again assumed an oval or spherical form and remained quiescent for a time. While in this form it was easily recognized, as the spherical shape caused the light passing through it to be refracted and gave the impression of a body having a dark contour and a central vacuole; but when it was flattened out and undergoing amœboid changes in form, it was necessary to focus very carefully and to have a good illumination in order to see it. The objective used was a Zeiss's one-twelfth-inch homogeneous oil immersion.

The changes in form which a single plasmodium, included in a red blood-corpuscle, was observed by Marchiafava and Celli to

undergo within a period of twenty minutes I shall show you upon the screen at the close of my address (see Fig. 1).

The confirmation of Laveran's discovery, as already stated, was first made by Richard in a communication to the French Academy of Sciences (February 20, 1882), then by Marchiafava and Celli

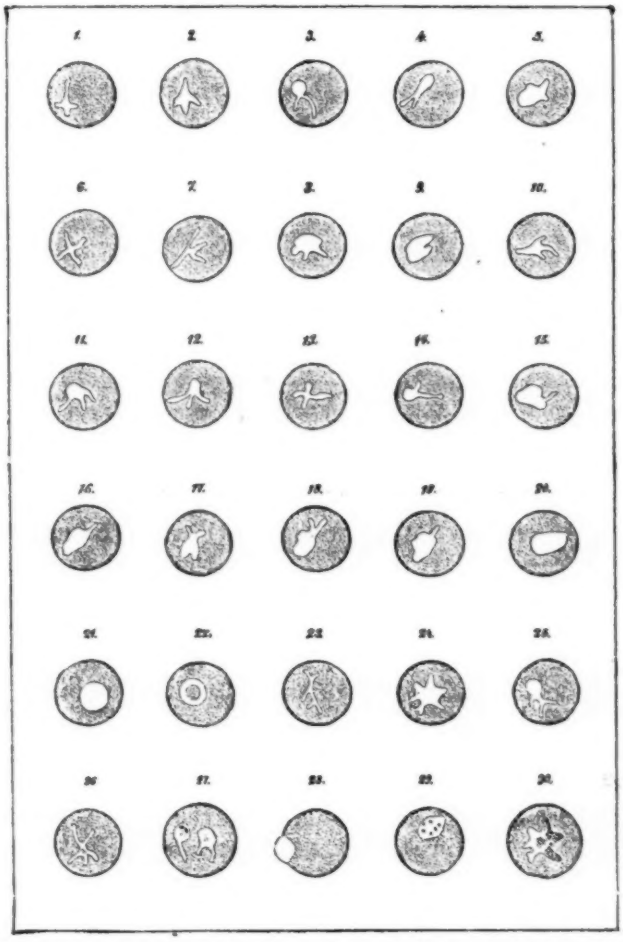

FIG. 1.—Figures 1 to 22 represent the changes in form which a single plasmodium, included in a red blood-corpuscle, was observed to undergo within a period of twenty minutes. Figures 23 to 27, 29, and 30 show other forms assumed by plasmodia, some with and some without pigment. Figure 28 shows a motionless plasmodium emerging from a red blood-corpuscle; the blood was taken after the paroxysm of fever and administration of quinine. (Marchiafava and Celli.)

(1883), and subsequently by Councilman and by Osler in this country, by Golgi in Italy, by Manson of England, and by many other competent microscopists in nearly all parts of the world where malarial diseases prevail.

The intracorpuscular development of the plasmodium has

been traced by Golgi and others, and results in the formation of a number of bodies arranged in the form of a rosette, with a mass of pigment granules at the center (see Fig. 2). The growth of the plasmodium seems to be at the expense of the hæmoglobin of

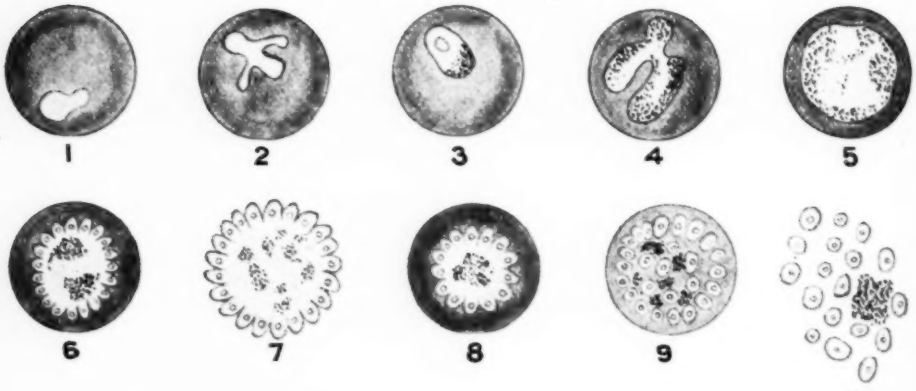

FIG. 2.—INTRACORPUSCULAR DEVELOPMENT OF THE PARASITE OF TERTIAN INTERMITTENT FEVER: 1, 2, young hyaline forms; 3, 4, more advanced pigmented forms; 5, fully grown parasite; 6, 7, 8, 9, segmentation and production of free spores (10).

the infected red blood-corpuscle, and the pigment granules are probably to be regarded as an excrementitious product. The segments of the rosette, which represents the final stage of intracorpuscular development, are finally set free by a breaking down of the remains of the corpuscle, and are supposed to correspond with the elementary body which invaded the corpuscle in the first instance. The periodicity of this class of fevers is believed to depend upon the fact that a certain time is required for the intracorpuscular development of the plasmodium, and that successive crops of these elementary bodies are set free at regular intervals. We have also in the blood of malarial-fever patients certain pigmented bodies which are believed to represent different stages in the development of the same parasite, or of a nearly related parasite, which is concerned in the ætiology of a different type of malarial fever. The form most frequently encountered is associated with the so-called "æstivo-autumnal" malarial fevers which prevail in the vicinity of Rome and elsewhere. The bodies characteristic of this type of fever are crescentic in form and contain black pigment granules, usually centrally located (see Fig. 3). These crescentic bodies are not usually found in the blood of persons suffering from intermittent fever of the tertian or quartan type. Golgi, who has made very extended studies of the blood of malarial patients, asserts that each intermittent paroxysm is associated with the segmentation of a group of intracorpuscular organisms—that is to say, that the paroxysm corresponds with the

ripening of a generation of the parasites. He also concludes from his observations that the number of parasites shown to be present by a microscopical examination of the blood corresponds, in a general way, with the severity of the attack. These observations have been confirmed by Osler, Antolisei, and others. Golgi has noted differences between the plasmodium as found in the tertian type of intermittent and that found in quartan fevers; and these differences are sufficiently marked to enable him to determine the type of fever by a blood examination. These observations have been confirmed by numerous competent pathologists in various parts of the world. When a daily paroxysm occurs, according to Golgi, this is due to the alternate development of two groups of quartan parasites. He has not been able to demonstrate a special parasite of quotidian fevers having a cycle of intracorpuscular development lasting twenty-four hours.

The differences between the evolution of the tertian and quartan parasite are summarized as follows by Laveran, from the data given by Golgi:

The tertian parasite completes its evolution in two days, the quartan in three days.

The amœboid movements of the tertian parasite are much more active than those of the quartan.

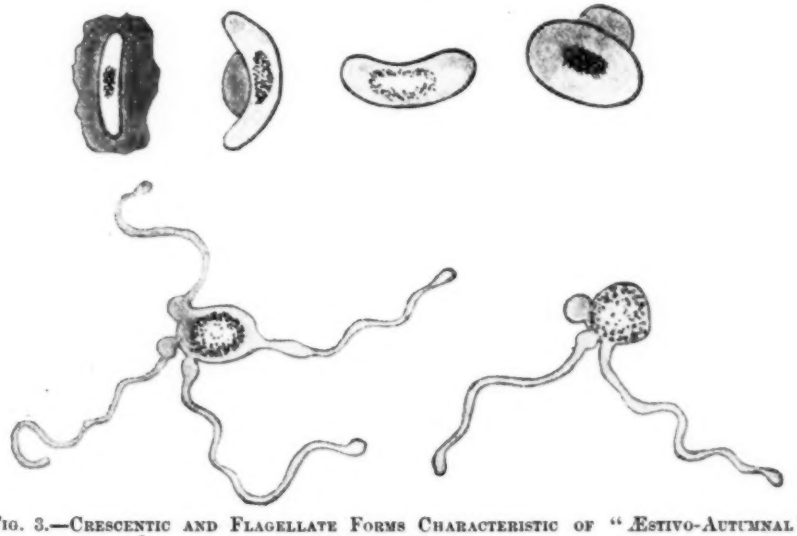

FIG. 3.—CRESCENTIC AND FLAGELLATE FORMS CHARACTERISTIC OF "ÆSTIVO-AUTUMNAL" MALARIAL FEVERS.

The tertian parasites cause a rapid decoloration of the red blood-corpuscles invaded by them, while the corpuscles retain their characteristic color when invaded by the quartan parasite up to the time that they are almost destroyed as a result of its intracorpuscular development.

In the quartan type the red blood-corpuscles containing the parasite have a tendency to become smaller than normal corpuscles; in the tertian type they are usually larger.

In the tertian the protoplasm of the parasites is very transparent; in the quartan it is less so, and the outlines are better defined.

In the quartan the pigment is seen in the form of grains or rods of greater size than in the tertian.

Finally, the principal difference is found in the segmentation of the intracorpuscular elements. The number of spores resulting from segmentation is greater in the tertian parasite—usually more than twice as many.

That these parasitic protozoa are in truth the cause of the forms of malarial fever with which they are found to be associated can scarcely be doubted, in view of the facts that this association is a constant phenomenon, that the infected blood-corpuscles are destroyed by the parasite, that a rapid loss of red corpuscles is one of the most marked results of malarial infection, and that the parasites disappear when quinine is administered in suitable doses, thus accounting for the specific action of this drug. Finally, it has been shown by inoculation experiments that when blood containing the plasmodium is drawn from the circulation of a malarial-fever patient and injected beneath the skin of a healthy person there is a reproduction of the parasite in the blood of the inoculated individual, and, after a certain period of incubation, typical malarial paroxysms occur. Successful inoculation experiments have been made by Marchiafava and Celli, by Gualdi and Antolisei, by Bein, by Bacelli, by Di Mattei, and others.

The life-history of the malarial parasite outside of the bodies of infected individuals has not been traced. Thus far attempts to cultivate it in artificial media have failed. Nor has the presence of the plasmodium been demonstrated in water or mud taken from the marshy localities which are recognized as the source of malarial fevers, and which we therefore believe to be the normal habitat of this mischievous micro-organism. The facts relating to the seasonal and regional occurrence of malarial fevers sustain the view that they are caused by living organisms, the external development of which depends upon conditions relating to temperature, moisture, vegetable growth and decay. But among the vast number of micro-organisms of an infinite variety of species found in localities which are recognized as malarious, the little specks of protoplasm which—with a first-class oil-immersion objective, and by careful manipulation of the light—we recognize as parasitic invaders of human blood-corpuscles could scarcely be detected, and could not be differentiated from other sporelike

bodies in the absence of methods for obtaining each species separately, in pure cultures.

Thayer and Hewetson, in their admirable monograph on the Malarial Fevers of Baltimore (1895), in which they give an account of six hundred and sixteen cases observed by themselves, have summarized their observations relating to the parasite as follows:

"We have distinguished three varieties of the malarial parasite:

"1. *The tertian parasite.*

"2. *The quartan parasite.*

"3. *The æstivo-autumnal parasite.*

"(1) The *tertian parasite* requires about forty-eight hours to accomplish its complete development, and is associated with relatively regular tertian paroxysms, lasting on an average between ten and twelve hours, associated, almost always, with the three classical stages—chill, fever, and sweating. Frequently, infection with two groups of tertian organisms gives rise to quotidian paroxysms; rarely, infection by multiple groups of organisms gives rise to more irregular, subcontinuous fevers.

"(2) The *quartan parasite* is an organism requiring about seventy-two hours for its complete development. It is rare in this climate, and is associated with a fever showing regular quartan paroxysms, similar in nature to those associated with the tertian organism. Infection by two groups of the parasite causes a double quartan fever (paroxysms on two days, intermission on the third). Infection with three groups of the parasite is associated with daily paroxysms.

"(3) The *æstivo-autumnal parasite* passes through a cycle of development, the exact length of which has not as yet been determined; it probably varies greatly, from twenty-four hours or under to forty-eight hours or more. But few stages of development of the parasite are found, ordinarily, in the peripheral circulation, the main seat of infection being, apparently, in the spleen, bone marrow, and other internal organs. Infection with this organism is associated with fevers varying greatly in their manifestations. There may be quotidian or tertian intermittent fever, or, more commonly, more or less continuous fever with irregular remissions. The individual paroxysms last, on an average, about twenty hours. The irregularities in temperature depend, probably, upon variations in the length of the cycle of development of the parasite, or upon infection with multiple groups of organisms.

"We have not been able to separate two distinct varieties of the æstivo-autumnal parasite, though we feel that more investigation is needed upon the subject.

"The cases of malaria in the spring and early summer are of the milder, more regularly intermittent varieties (tertian and quartan fever), the severe æstivo-autumnal infections beginning to appear only in the later summer, and reaching their maximum in September."

Manson has recently suggested that the mosquito is an intermediate host for the malarial plasmodium. We have an analogy for this in the part played by the mosquito in withdrawing embryo filariæ (*Filaria sanguinis hominis*) from the blood of infected individuals and returning them to the stagnant pools frequented by the insect. Manson says, in discussing this hypothesis in his Gulstonian Lectures (1896):

"We can readily understand how the mosquito-bred plasmodium may be swallowed by a man in water, as so many disease germs are, and we can readily understand how it may be inhaled in dust. Mosquito-haunted pools dry up. The plasmodia in the larvæ and those that have been scattered about in the water, finding themselves stranded by the drought, and so placed in a condition unfavorable for development, pass into a resting stage, just as they do when by quinine or other means man is rendered temporarily unsuited for their active life. They may, probably do, become encysted, as so many of the protozoa do in similar circumstances. The dried sediment of the pool, blown about by winds and currents of air, is inhaled by man, and so the plasmodium may find its way back again to the host from whom its ancestors had, perhaps, started generations back."

This theory appears plausible, but we find it difficult to believe that man is essential for the completion of the life cycle of the plasmodium, for the most concentrated and deadly malarial emanations may be given off from marshy places which are far removed from the haunts of men. It may be, however, that the mosquito is an essential factor in the development of the plasmodium, and that man, instead of being a necessary intermediate host, only serves occasionally, and in a certain sense accidentally, as such. Perhaps other mammals or birds may serve the same purpose. It has frequently occurred to the writer that the malarial plasmodium, like other amœboid protozoa, may find its normal habitat, external to the bodies of its insect or animal hosts, upon the stems and leaves of water plants, rather than in the water itself. The fact that malarial fevers do not prevail in the vicinity of swamps when the marsh vegetation is submerged by high water is in favor of this view; as is also its apparent need of plenty of oxygen, which we infer from its active multiplication in the blood and its parasitic invasion of the red blood-corpuscles.

Possibly the mosquito is an intermediate host for the *Plasmodium malariæ* on a larger scale than Manson suggests. The

natural food of this insect is the juices of plants, and, no doubt, a vast majority of them never have a chance to fill themselves with the rich red fluid from their human victims which they are so eager to substitute for their normal diet when opportunity offers. If, as we have suggested, the plasmodium abounds upon the stems and foliage of herbaceous plants in marshy localities, the mosquito would be very likely to pick it up in following its everyday method of gaining a livelihood.

Parasitic protozoa, closely resembling the malarial parasite, have been found in the blood of birds and of reptiles, and possibly one or more species of lower animals may serve as an "intermediate host" for the hæmatozoon under consideration. Laveran has given a drawing, in his work on Paludism, of a parasite found in the blood of the lark, which is evidently of the same family. The fact that a parasite may develop in the blood, or elsewhere, in one or more species of animals without giving rise to any evident symptoms of disease can not be taken as evidence that it is not pathogenic for man, or for some other animal. On the contrary, we have numerous instances which show that animals may have a natural or acquired immunity to the pathogenic action of parasitic micro-organisms which are deadly for other animals of the same or different species.

Texas fever, an infectious disease of cattle which prevails as an endemic disease in certain regions in the southern portion of the United States, has been shown, by the researches of Theobald Smith and other bacteriologists belonging to the Agricultural Department, to be due to a blood parasite belonging to the protozoa (*Pyrosoma bigeminum* of Smith). In this disease the tick has been shown to be the intermediate host of the parasite. The ticks which fall from infected animals give birth to a numerous progeny in the pastures frequented by them, and these young ticks attach themselves to other animals which subsequently feed in the same pastures and transmit to them the fatal infection.

The tsetse fly disease of Africa has recently been shown by the researches of Bruce to be due to a flagellate infusorium which is found in the blood of infected animals. This disease is fatal to the ox, the horse, the dog, the sheep, and the ass, but not to the indigenous wild animals in the region infested by the tsetse fly. The researches of Bruce indicate that the fly acts as a carrier of the parasite from diseased to healthy animals. He has shown by experiment that after feeding on the blood of an infected animal the tsetse fly can communicate the disease to a healthy animal by its bite. After a short period of incubation the hæmatozoa appear in the blood concurrently with the development of fever, and followed by rapidly progressive anæmia, dropsy, and death.

The so-called "surra disease," which prevails in certain por-

tions of India, is believed to be due to a similar parasitic protozoan (*Trypanosma Evansi*). According to Lingard, this infusorium exists as an innocuous parasite in the blood of rats in India. It is not pathogenic, or only feebly so, for the native ox of India, but gives rise to a fatal infectious disease in horses, dogs, and camels.

Another pathogenic micro-organism belonging to the protozoa is the *Amœba coli*, which is found in great numbers in the large intestine in cases of tropical dysentery and also in liver abscess secondary to this disease.

The rapid progress of our knowledge of the bacteria has been due to the fact that satisfactory methods (staining) have been devised for detecting these minute micro-organisms in the blood and tissues of infected individuals and for cultivating them in artificial media. Unfortunately, these methods have only a limited utility when applied to investigations relating to the protozoa. The bacterial cell has considerable stability, owing to its cellulose envelope (cell wall), and it is readily stained by the aniline dyes. The protozoa, on the contrary, very readily undergo disintegration, and the more fluid protoplasm of these unicellular organisms is not so easy to demonstrate by the usual staining reagents. It has also been found very difficult, and in many cases quite impossible, to obtain pure cultures in artificial media. Again, the recognition of protozoa in the blood of infected animals by means of the microscope requires special skill in making preparations, in the management of the light, etc., and expert knowledge of the normal elements of the blood and of the changes they undergo as a result of various methods of preparation. This is illustrated by the fact that many persons, more or less familiar with the use of the microscope, have failed to discover the malarial parasite in blood which undoubtedly contained it, while others have evidently mistaken vacuoles in normal blood-corpuscles for the plasmodium, the crenated red corpuscles for pigmented cells, and deformed corpuscles for malarial crescents.

Notwithstanding the painstaking researches which have been made during the past few years for the purpose of determining the nature of certain bodies which may be demonstrated by special staining methods in the cells of carcinomatous tumors, we are still uncertain as to the nature and ætiological import of these bodies. Some investigators believe them to be protozoa, and from their location infer that they are the specific ætiological agents in the development of malignant growths of this character. But, so far as we are informed, this view has not as yet received any very substantial support, and has not been accepted by the leading pathologists of the world.

The presence of amœboid micro-organisms in the contents of

the pustules of variola and in vaccine lymph has been reported by several investigators: Guarnieri (1892), Monti (1894), Piana and Galli-Valerio (1894), L. Pfeiffer (1894), Clarke (1895), von Sicherer (1895), E. Pfeiffer (1895). Guarnieri in 1892 published a paper in which he claimed to have cultivated the amœboid micro-organism found by him in vaccine lymph by successive inoculations in the cornea of rabbits. E. Pfeiffer has since (1895) confirmed this observation, and has seen the parasite undergoing amœboid movements and in progress of multiplication by spontaneous fission. During the past two years investigations relating to the ætiology of vaccinia and variola have been made at the Army Medical Museum in Washington, by Major Walter Reed, surgeon United States Army. These investigations show that in vaccinated monkeys and in children an amœboid parasite makes its appearance in the blood on the sixth or seventh day after vaccination, and may be found during a period of from five to seven days, when it disappears. Reed has found the same parasite in the blood of patients with variola and in his own blood after an accidental vaccination in the finger. The parasites are not numerous. They are less than a third the diameter of a red blood-corpuscle, and may be observed to undergo amœboid movements in a drop of blood, properly mounted for microscopical examination, during a period of twenty-four hours or more. These amœboid bodies, like the malarial parasite, would be easily overlooked by one not an expert in blood examinations.

The presence of a ciliated amœboid micro-organism in the mucous secretion coughed up by children suffering from whooping-cough has recently been reported by Deichler and confirmed by Kourlow. This may prove to be the cause of the disease, but further researches will, of course, have to be made before this can be determined. In view of the extended investigations made during the past few years by competent bacteriologists, it seems probable that in most of those infectious diseases in which the specific infectious agent has not yet been discovered it belongs to some other class of micro-organisms than the bacteria; and it seems not improbable that some of them at least will prove to be due to infection by "germs" belonging to the class to which your attention has been invited in the present address—viz., the pathogenic protozoa.

M. HENRI DE KERVILLE describes fifteen yew trees in Normandy which are supposed to be a thousand years old and more; a number of oaks from three hundred to nine hundred years old; cedar trees from a hundred to a hundred and fifty; a hawthorn, two hundred; a pear tree, more than a hundred; a holly tree, a hundred or a hundred and fifty; and an American tulip tree, a hundred or a hundred and twenty years old.

THE STABILITY OF TRUTH.*

By DAVID STARR JORDAN,
PRESIDENT OF LELAND STANFORD JUNIOR UNIVERSITY.

WITHIN the last few years three notable assaults have been made on the integrity of science. Two of these have come from the hostile camp of mediæval metaphysics, another from the very front of the army of science itself. Salisbury, Balfour, and Haeckel agree in this, that "belief" may rest on foundations unknown to "knowledge," and that the conclusions of science may be subject to additions and revisions in accordance with the demands of "belief." To some considerations suggested in part by Balfour's Foundations of Belief and Haeckel's Confession of Faith of a Man of Science I invite your attention to-day.

The growing complexity of civilized life demands with each age broader and more exact knowledge as to the material surroundings and greater precision in our recognition of the invisible forces or tendencies about us. We are in the hands of the Fates, and the greater our activities the more evident become these limiting conditions. The secret of power with man is to know its limitations. To this end we need constantly new accessions of truth as to the universe and better definition of the truths which are old. Such knowledge, tested and placed in order, we call science. Science is the gathered wisdom of the race. Only a part of it can be grasped by any one man. Each must enter into the work of others. Science is the flower of the altruism of the ages, by which nothing that lives "liveth for itself alone." The recognition of facts and laws is the province of science. We only know what lies about us from our own experience and that of others, this experience of others being translated into terms of our own experience and more or less perfectly blended with it. We can find the meaning of phenomena only from our reasoning based on these experiences. All knowledge we can attain or hope to attain must, in so far as it is knowledge at all, be stated in terms of human experience. The laws of Nature are not the products of science. They are the human glimpses of that which is the "law before all time."

Thus human experience is the foundation of all knowledge. Even innate ideas, if such ideas exist, are derived in some way from knowledge possessed by our ancestors, as innate impulses to action are related to ancestral needs for action.

But is human experience the basis also of belief as it is of knowledge?

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* President's address, California Science Association meeting, Oakland, December, 1895.

One of the questions of the day is this: Is "to believe" more than "to know"? Shall a sane man extend belief in directions where he has no knowledge and in lines outside the reach of his power to act? Can belief soar in space not traversable by "organized common sense"? If such distinction is made between "knowing" and "believing," which of the two has precedence as a guide for action? Is belief to be tested by science? Or is science useful only where belief is indifferent to the subject-matter? If belief is subordinate to the tests of science, to be accepted or rejected in the degree of its accord with human experience, then it is simply an annex to science, a footnote to human experience, and the authority of the latter is supreme. If, however, truth comes to us from sources outside of human experience, it must come in some pure form, free from human errors. As such it must claim the first place. In this event the progress of science will be always on a lower plane than the progress of belief.

In a recent address before the British Association for the Advancement of Science, the Marquis of Salisbury made in brief this contention: The central thought of modern science is evolution, the change from the simple to the complex. This implies not only the fundamental unity of all life, but the fundamental unity of all matter and perhaps of all force as well. In spite of the claims of scientific men, even the fact of organic evolution is far from demonstration; while of inorganic evolution, the development of the chemical elements, science can tell us nothing. Wherefore the marquis, in view of the failure of science to keep up with the progress of belief, grows jocose and patronizing. His advice to his scientific associates might be stated in the words of Thackeray, that "we should think small beer of ourselves and pass around the bottle."

More recently another English statesman, Mr. Arthur J. Balfour, has discussed the Foundations of Belief. He has shown that the methods of science can not give us *absolute truth*. Its methods are "of the earth, earthy." Its claim of trust in the infallibility of its own processes has no higher authority than the claim of infallibility made at times by religious organizations. For as only the senses and the reason can be appealed to in support of the claims of the senses and the reason, the argument of science is of necessity reasoning in a circle. Science can give us no ground solid enough to bear the weight of belief. Belief must exist, and it may therefore rest on the innate needs of man and the philosophy which is built on these needs in accordance with the authority which the human soul finds sufficient.

Balfour calls attention to the fact that human experience is not in its essence objective. It consists only of varying phases

of consciousness. These phases of consciousness at best only point toward truth. They are not truth itself. They vary with the varying nerve cells of each individual creature on whom phases of consciousness are impressed, and again with the changes in the cells themselves. The tricks of the senses are well known in psychology, as is also the failure of the senses as to material outside their usual range. Life is at best "in a dimly lighted room," and all the objects about us are in their essence quite different from what they seem. This essence is unknown and unknowable. We are well aware that we have no power to recognize all phases of reality. The electric condition of an object may be as real as its color or its temperature, and yet none of our senses respond to it. Our eyes give but an octave of the vibrations we call light, and our ears are dull to all but a narrow range in pitch of sound.

Likewise is reason to be discredited. The commonest things become unknown or impossible when viewed "in the critical light of philosophy." Balfour shows that the simple affirmation, "the sun gives light," loses all its meaning and possibility when taken out of the category of human experience and discussed in terms of philosophy. In like manner can any simple fact be thrown into the category of myths and dreams. A man can be led by the methods of metaphysics to doubt the existence of himself or of any object about him. For instance, take the discussion of "John's John" and of "Thomas's John," as given by Dr. Holmes. Is the real John the John as he appears to John himself? Or is he real only in the form in which Thomas regards him, or as he looks to Richard and Henry, whose interest in him is progressively less? All we know of the external universe is through the impressions made directly or indirectly on our nervous systems and through recorded impressions made on the systems of others; and a part of this external universe we ourselves are. All that we know of ourselves is that which is external to ourselves. Thus with all this, each man forms in his mind a universe of his own. "My mind to me a kingdom is," and this kingdom in all its parts is somewhat different from any other mental kingdom. It is continually changing. It was made but once, and will never be duplicated. When my vital processes cease, this kingdom will vanish "like the baseless fabric of a vision, leaving not a wreck behind." Our mind is the "stuff that dreams are made of"—and our bodies—what are they? Physically each man is an alliance of animals, each one of a single cell, each cell with its processes of life, growth, death, and reproduction, each one with its own "cell-soul" which presides over these processes. In the alliance of these cells, forming tissues and organs, we have the phenomena of mutual help and mutual de-

pendence. In man we find the phenomena of animal life on a larger and more differentiated scale, but the fact of self grows faint as our study is continued. What is this vital force, and what have we to do with it; and is it, after all, more than another name for the movement of molecules? And of what are our cells composed? Carbon, oxygen, hydrogen, nitrogen, we know by name, but what are these in essence, and how are they different one from another? Does matter really exist? Mathematicians have claimed that all relations of ponderable matter and force might exist if the atoms of matter were not realities, but simply relations. Each of these atoms possessed of attraction or weight may be a vortex ring or eddy in the ether, the ultimate units of which have vibration but not attraction. If, therefore, the body of man be an alliance of millions of animal cells, each cell formed of millions of eddies in an inconceivable and impossible ether; if all things around us are recognized only by their effect on the most unstable part of this unstable structure, then again "let us think small beer of ourselves and pass around the bottle."

Each fact or law must be expressed in terms of human experience, if it is expressed or made intelligible at all. To such terms, the word reality applies, and beyond such reality we have never gone. Apparently beyond it we can not go, at least in the only life we have ever known. Balfour's plea for "philosophic doubt" of the reality of the subject-matter of science is simply a rhetorical trick of describing the known in terms of the unknown. By the same process we may call a fishwife an "abracadabra" or an "icosahedron," and by the same process we can build out of the commonest materials "an occult science" or a new theosophy. The measure of a man is the basis of human knowledge, and whatever can not be brought to this measure is no part of knowledge. In converse fashion Balfour speaks of the unknown in terms of the known; of the infinite in terms of human experience. This gives to his positive foundations of belief an appearance of reality as fallacious as the unreality he assigns to the foundations of science. This appearance of reality is the base of Haeckel's sneer at conventional religion as belief in a "gaseous vertebrate."

It is perfectly easy for science to distinguish between subjective and objective nerve conditions. It can separate those produced by subjective nervous derangements, or by conditions already passed, from those which are contemporary impressions of external things. It is perfectly easy for common sense to do the same. To be able to do so is the essence of sanity. The test of sanity is its livableness, for insanity is death. The borderland of spirit of which we hear so often of late, the land in which subjective and objective creations jostle each other, is the borderland of

death. The continued existence of animals and men is based on the adequacy of their sensations and the veracity of their actions. The existence of any creature is, in general, proof of the sanity of its ancestry, or at least of the sanity of those who controlled the actions of its ancestors.

This veracity is gauged by the degree of coincidence of subjective impressions and objective truth. Whoever makes a fool's paradise or a fool's hell of the world about him is not allowed to live in it. This fact in all its bearings must stand as a proof that the universe is outside of man and not within him. In this objective universe which lies outside ourselves we find "the ceaseless flow of force and the rational intelligence that pervades it." No part of it can be fully understood by us, but in it we find no chance movement, "no variableness nor shadow of turning." That such a universe exists seems to demand some intelligence capable of understanding it, of stating its properties in terms of absolute truth as distinguished from those of human experience. Only an Infinite Being can be conceived as doing this, hence such knowledge must enter into our conception of the Infinite Being, whatever may be our theology in other respects. For to know an object or phenomenon in its fullness, "all in all," "we should know what God is and man is."

It is therefore no reproach to human science that it deals with human relations, not with absolute truths. "The ultimate truths of science," Dr. Schurman has said, "rest on the same basis as the ultimate truths of philosophy"—that is, on a basis that transcends human experience. This is true, for science has no "ultimate truths." There are none known to man. "The perfect truth," says Lessing, "is but for Thee alone." With ultimate truths human philosophy tries in some fashion to deal. To look at the universe in some degree through the eyes of God is the aim of philosophy. In its aim it is most noble. Its efforts are a source of strength in the conduct of human life. But its conclusions are not truth. They range from the puerile to the incomprehensible, and only science—that is, "common sense"—can distinguish the two. For this reason just in proportion as philosophy is successful it is unfit as a basis of human action. Human knowledge and action have limitations. The chief of these is that whatever can not be stated in terms of human experience is unintelligible to man. Whatever can not be thought can not be lived.

Philosophy has its recognized methods of procedure. These are laid down in the mechanism of the human brain itself. Science has found these methods untrustworthy as a means of reaching objective truth. The final test of scientific truth is this: Can we make it work? Can we trust our life to it? This test the

conclusions of philosophy can not meet. In so far as they do so they are conclusions of science. As science advances in any field philosophy is driven away from it. The fact has been often noted that every great conclusion of science has been anticipated by philosophy, in most cases by the philosophy of the Greeks. But every conclusion science has shown to be false has been likewise anticipated. The Greeks taught the theory of development centuries before Darwin. But if Darwin's studies in life variation had led to any other result whatsoever, he would have been equally anticipated by the Greeks. In other words, every conceivable guess as to the origin and meaning of familiar phenomena has been exhausted by philosophy. Some of these guesses contain elements of truth. Which of these have such elements it is the business of Science to find out. Philosophy has no means of doing so. A truth not yet shown to be true is in science not a truth. It has no more validity than any other generalization not shown to be false. Helmholtz tells us that philosophy deals with such "*schlechtes Stoff*," such bad subject-matter, that it can give no trustworthy conclusions. Science alone can give the test of human life. The essence of this test is experiment.

The tests of philosophy are mainly these: Is the conception plausible? Has it logical continuity? Is it satisfying to the human heart? And in this connection the figurative word "heart" is best left undefined. In other words, its sources and its tests are alike subjective—intellectual or emotional. If we take from philosophy the "heart" element, the personal equation, it becomes logic or mathematics. Mathematics is metaphysics working through methods of precision. It is a most valuable instrument for the study of the relations and ramifications of knowledge, but it can give no addition to knowledge itself. Dr. William James defines metaphysics as "the persistent attempt to think clearly." This definition is good so far as it goes, but to think clearly is a function of science also. Metaphysics is rather the "attempt to think clearly" in fields where exact data are unattained or unattainable. In so far as philosophy is simply clear thinking it is a most valuable agency for testing the deductions of science. But, while it can reject false conclusions, it can add no new matter of its own.

For example, the claim is made in the name of evolutionary philosophy that all matter is one in essence, therefore all the chemical elements, some seventy in number, must be the same in substance. In this case all must be derived from the same primitive stuff, and the hypothetical basis of all ponderable matter has been called protyl. As a working theory this is most ingenious. But is it science? Is it worthy of belief? Certainly Science

knows nothing as yet of the identity of these elements. In a general way Science is finding out that the processes of Nature are more complex than man supposed, while the elements on which these processes rest, matter and force, are more simple. How far can this generalization go? To every test human experience has devised each chemical element remains the same, its atoms unchangeable as well as indestructible. Therefore, to speak of them as forms of one substance is to go beyond knowledge. Science does not teach this. But to philosophy this offers no difficulty. It is still plausible to suppose that by some combination of primitive units these variant atoms are formed. Such an idea would have logical continuity, and, as we are becoming used to the notions of primal unity, we find such an idea satisfying to our consciousness. If this is true, somewhere, somehow, lead will be resolved into its primal elements, and these elements may be united in the form of gold. Then will the dream of the alchemist become fact. But Science must make this objection: "Not until then." Such transmutation is as yet no part of knowledge. We certainly do not know that lead can be changed into that which is transmutable into gold. We do not know it, I say; but may we believe it? Is the foundation of belief less secure than that of knowledge? Can we trust Philosophy to tell us what to believe while we must look to Science to tell us what we know?

This brings us to the question of definitions. If knowledge and belief are of like rank, both must rest on science, and the results of philosophy must come to science only as hints or suggestions as to lines of research.

If knowledge implies stability and belief does not, the relation of the two is also clear. In that case belief would be a word of light meaning, expressive of whim or of the balance of opinion. Such weight as it has would be drawn from its association with prejudice. Belief would then be the pretense of knowledge as compared with knowledge itself. Among its paths life can not march with courage and effectiveness. It is not for such beliefs as this that the martyrs have lived or died. Their inspiration was the positive belief of science or the negative belief of the falsity of the ideas that tyranny or superstition had forced upon them.

To avoid a discussion foreign to my purpose, I wish, if possible, to separate the word belief—as used in this paper—from the word religion. The essence of belief is the categorical statement of propositions. These may be built into a creed, which word is the Latin synonym of belief.

Religion implies rather a condition of the mind and heart—an attitude, not a formula. Faith, hope, charity do not rest on logic

or observation. Religion implies a reverent attitude toward the universe and its forces, a kindly feeling toward one's fellow mortals and immortals. "Pure religion and undefiled" has never formulated a "creed," has never claimed for itself orthodoxy. It has no stated ritual and no recognized cult of priests. Much that passes conventionally as religious belief among men has no such quality or value. It is simple the *débris* of our grandfathers' science. While religion and belief become entangled in the human mind, so as not to be easily separable, the one is not necessarily a product of the other. In the higher sense no man can follow or inherit the religion of another. His religion, if he has any, is his own. Only forms can be transferred, realities never; for realities in life are the product of individual thought and action.

As the third of these efforts to discredit science I have placed Prof. Haeckel's recent address, The Confession of Faith of a Man of Science. This remarkable work is an eloquent plea for the acceptance of the philosophic doctrine of monism as the fundamental basis of science. This doctrine once adopted, we have the basis for large deductions, which forestall the slow conclusions of science; for monism brings the necessity for the belief in certain scientific hypotheses resting as yet on no foundations in human experience, incapable as yet of scientific verification, but which are a necessary part of the monistic creed. The primal conception of monism is, first, "that there lives one spirit in all things, and that the whole cognizable world is constituted and has been developed in accordance with one common fundamental law." This involves the essential oneness of all things, matter and force, object and spirit, Nature and God. This philosophical conception of monism and pantheism can not be made intelligible to us, because it can be stated in no terms of human experience. But it has certain necessary derivatives, according to Haeckel, and these are intelligible, because their subject-matter is available for scientific experiment.

First among these postulates, called by Haeckel "Articles of Faith," comes "the essential unity of organic and inorganic Nature, the former having been evolved from the latter only at a relatively recent period." This involves the "spontaneous generation" of life from inorganic matter. It also resolves "the vital force," or the force which appears in connection with protoplasmic structures, into properties shown by certain carbon compounds under certain conditions. Life is thus, in a sense, an emanation of carbon, "the true maker of life," according to Haeckel "being the tetraedral carbon molecule."

This "Article of Faith" implies also the unity of the chemical elements, each of which is a product of the evolution of the primal unit of matter. Force and matter are likewise one, because

neither appears except in the presence of the other. The inheritance of acquired characters is also made a corollary of monistic belief.

Now, all these hypotheses are possibly true, but none of them are as yet conclusions of science. They meet the conditions required by philosophy. They are plausible. They have the merit of logical continuity, and, excepting to those persons biased by early subjection to contrary notions, they satisfy the "human heart." There should be no natural repugnance to monism or to pantheism, difficult as it is to associate the idea of truth and reality with either or with the opposite of either. Speaking for myself, I feel no repugnance to them. They lend themselves to poetry; they appeal to the human heart. In Haeckel's own words, referring to something else, "such hereditary articles of faith take root all the more firmly, the further they are removed from the rational knowledge of Nature and enveloped in the mysterious mantle of mythological poesy." The present resistance to them may in time be turned into superstitious reverence for them; for, of all the philosophic doctrines brought down as lightning from heaven for the guidance of plodding man, these seem most attractive, and least likely to conflict with the conclusions of science.

But can we give them belief? Let us pass by the doctrine of monism, with which science can not concern itself. What of the corollaries? Spontaneous generation, for example, has been the basis of many experiments. Like the transmutation of metals, it seems reasonable to philosophy. The one idea has been the Will-o'-the-wisp of biology as the other has of chemistry. We know absolutely nothing of how, if ever, non-life becomes life. So far as we know, generation from first to last has been one unbroken series—"all life from life." We have no reason to believe that spontaneous generation exists under any conditions we have ever known. We have likewise reason to believe that if it exists at all we have no way of recognizing it. The organisms we know have all had a long history. Even the smallest shows traces of a long ancestry, a long process of natural selection, and of many concessions to environments. We know of no life that does not show such concessions. We know no creature that does not show homologies with all other living beings whatsoever. So far as this fact goes, it tends to show that all life is one. If this is true, spontaneous generation, whatever it may be, is not one of the ever-present phenomena of life.

If life does now appear without living parentage, if organisms fresh from the mint of creation now appear from inorganic matter, they are so simple that we can not know them. They are so small that we can not find them. They would be made, we may suppose, each of a small number of molecules. If there is truth in

the calculations of Lord Kelvin and others, that a molecule is as small in a drop of water as a marble in comparison with the earth, then we may not look for these creatures. If we can not find them, we do not know that they exist. If we do not *know* that they exist, shall we "believe" that they do? Is it not better, as Emerson suggests, that we should not "pretend to know and believe what we do not really know and believe"?

It may be that the existence of life in a world once lifeless renders spontaneous generation a "logical necessity." But the "logical necessity" exists in our minds, not in Nature. Science knows no "logical necessity," for the simple reason that we are never able to compass all the possibilities in any given case.

If we are to apply philosophic tests to the theories of reincarnation, we may find them equally eligible as articles of belief. They are plausible, to some minds at least; they have logical continuity. They are satisfying to the human heart, at least this is claimed by their advocates. Their chief fault is that they can be brought to no test of science and have no basis in inductive knowledge. In other words, their only reality is that of the vapors of dreamland. If plausibility and acceptability serve as sufficient foundations for belief, then belief itself is a frail and transient thing, no more worthy of respect than prejudice, from which indeed it could not be distinguished. Some such idea as this seems to be present in the mind of Mr. Gladstone. In a recent article, quoting in part the language of the honest Bishop Butler, he ascribes to certain doctrines "a degree of credibility sufficient for purposes of religion, and even a high degree of probability." In other words, religion, which deals with human hopes and fears, has less need of certainty than science, which is ultimately concerned with human action.

Haeckel makes the same distinction clearly enough. He uses the term "belief" for "hypotheses or conjectures of more or less probability" by which "the gaps empirical investigation must leave in science are filled up. . . . These," he says, "we can not indeed for a time establish on a secure basis, and yet we may make use of them in the way of explaining phenomena, in so far as they are not inconsistent with the rational knowledge of Nature. Such rational hypotheses," he says, "are scientific articles of faith." It is not clear, however, that so large a name as faith need be taken for working hypotheses confessedly uncertain or transient. The word "make-believe," used by Huxley in some such connection, might well be applied to hypothetical "articles of faith," until given a basis by scientific induction. But it seems to me that it is not necessary for the man of science to say "I believe," in addition to "I know." He should put off the livery of science when he enters the service of the Delphian oracles.

That all the doctrines above mentioned are necessarily included in monism may perhaps be doubted. Monism would still flourish were all these theories disproved. For human philosophies have wonderful recuperative power. Their basis is in the structure of the brain itself, and external phenomena are only accessory to them.

If monism is purely a philosophic conception, it can have no necessary axioms or corollaries, except such as are involved in its definition. These could not be scientific in their character, because they could in no way come into relation with the realities of human life. If, however, monism be a generalization resting in part on human experience, then it must be tested by the methods of science. Until it is so tested, however plausible it may be, it has no workable value. There is no gain in giving it belief, or in calling it truth. Still less should we stultify ourselves by pinning our faith to its postulates as to the matters yet to be decided by experiment, and to be settled by human experience only. Haeckel says, for example: "The inheritance of characters acquired during the life of the individual is an indispensable axiom of the monistic doctrine of evolution. . . . Those who with Weismann and Galton deny this entirely exclude thereby the possibility of any formative influence of the outer world upon organic form." Here we may ask, Who knows that there is any such formative influence? What do we know of this or any other subject beyond what in our investigations we find to be true? When was monism a subject of special revelation, and with what credentials does it come, that one of the greatest controversies in modern science should be settled by the simple word? "*Roma locuta est; causa finita est*" is a dictum no longer heeded by science.

The great bulk of the arguments in favor of the heredity of acquired characters, as well as most of those in favor of the opposed dogma, the unchanged continuity of the germ-plasm, are based on some supposed logical necessity of philosophy. All such arguments are valueless in the light of fact. Desmarest's suggestion to the contending advocates of Neptunism and Plutonism was, "Go and see." When they had seen the action of water and the action of heat, the contest was over, for argument and contention had vanished in the face of fact. To believe without foundation is to discredit knowledge. Such "Confessions of Faith" on Haeckel's part lead one to doubt whether in his zeal for belief he has even known what it is to know. In fact, if we may trust his critics, much of Haeckel's scientific work is vitiated by this mixture of "believe" and "make-believe." The same confusion is shown in this remarkable passage which President White quotes from John Henry Newman: "Scripture says that

the sun moves and the earth is stationary, and science that the earth moves and the sun is comparatively at rest. How can we determine which of these opposite statements is the very truth till we know what motion is? If our idea of motion is but an accidental result of our present senses, neither proposition is true and both are true; neither true philosophically; both true for certain practical purposes in the system in which they are respectively found."

Again, if we are to allow the revision of the generalizations of science by the addition of acceptable but unverified doctrines, we must allow the right of similar revision by rejection. Mr. Wallace, for example, would be justified in adding to the certainties of organic evolution his idea of the special creation of the mind of man. The old notion of the separate existence of the Ego, which plays on the nerve cells of the brain as a musician on the keys of a piano, would still linger in psychology. The astral body would hover on the verge of physiology, and a strong plea would go up for the reality of Santa Claus.

I have a scientific friend who finds it necessary to exclude by force, from his biological beliefs, all that is unpleasant in the theories of evolution. And he has the same right to do this that Prof. Haeckel has to insist that any scientific beliefs, for which science has yet no warrant, are a necessary part of the orthodoxy of science.

For Haeckel is not content to speak for himself, asking tolerance by tolerance toward others. His belief is no idiosyncrasy of his own. He speaks for all. Every honest, intelligent, courageous scientific man, he tells us, so far as he is truthful, competent, and brave, shares the same belief. His confession of faith is nothing if not orthodox. He says:

"This monistic confession has the greater claim to an unprejudiced consideration in that it is shared, I am firmly convinced, by at least nine tenths of the men of science now living; indeed, I believe, by all men of science in whom the following four conditions are realized: (1) Sufficient acquaintance with the various departments of natural science, and in particular with the modern doctrine of evolution; (2) sufficient acuteness and clearness of judgment to draw by induction and deduction the necessary logical consequences that flow from such empirical knowledge; (3) sufficient moral courage to maintain the monistic knowledge, so gained, against the attacks of hostile dualistic and pluralistic systems; and (4) sufficient strength of mind to free himself by sound, independent reasoning from dominant religious prejudices, and especially from those irrational dogmas which have been firmly lodged in our minds from earliest youth as indisputable revelations."

Against such assumption we must protest. I have nothing against the doctrines save that they are not yet true. In themselves, as I have said, they are attractive. One may naturally feel a hopeful interest in wide-reaching theories which seem possible, but are still unproved or unworkable. This is, however, not "belief." It is rather open-mindedness, open to negative evidence as well as to the positive.

As science goes wherever the facts lead, so science must stop where the facts stop. It can not add to its methods the running high jump, nor place the divining rod with the microscope, crucible, and calculus among its instruments of precision. Beyond the range of scientific knowledge extend the working and the unworkable hypotheses. Beyond the confines of these extends the universe of the mind, the boundless realm which is the abode of philosophy. None should better realize those distinctions than men of science.

[*To be continued.*]

A YEAR OF THE X RAYS.

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THE incredulity which greeted the first reports of Prof. Röntgen's famous discovery gave place, upon their confirmation, to a delirium of enthusiasm, experimentation, and expectation. So startling and so novel were the facts reported by the discoverer that no prediction seemed too wild, no penetration into the unknown either impossible or improbable. The condition of mind actually prevailing at that time with a large number of persons is admirably shown by President Jordan's amusing article on the Sympsychograph in the Popular Science Monthly for September, 1896.

Prof. Röntgen reported his investigations in a paper before the Physico-Medical Society of Würzburg, in December, 1895. The account of his paper was transmitted to America in a few brief statements, January 7, 1896, the full report not arriving until some weeks later. Popular interest was focused upon the fact that the X rays, as its discoverer provisionally named the mysterious agency, would reveal a bony skeleton within its case of fleshy tissue, and the famous picture of a hand in which the bones thus stood revealed was soon to be found in every city of Europe and America. The realism of this weird picture simply fascinated all who beheld it. Attempts were made to repeat and extend the original experiments wherever there was any semblance of apparatus suited to the purpose. An electric poten-

tial high enough to give a spark of several inches in air, and a vacuum tube in which the spark was to be discharged, seemed to be requisites, and wherever these were obtainable the experiments were attempted. Poor facilities led to efforts to dispense with good ones, the prevailing meagerness of equipment becoming thereby a means all the earlier of deciding the limitations for successful operation. Of course, the excitement quieted when the novelty wore off, but investigations in this new field must continue for a long time.

The pure physics of the subject was, naturally, the side which most appealed to scientific professors. How was the strange agent to be set to work, and how did it work? Was it light, or was it electricity? Was it material, or ethereal? Was it due to the cathode or to the anode terminal of the vacuum tube? The year's work upon these questions leaves them answered only partially and unsatisfactorily. Very little indeed has been added to the facts brought out by Dr. Röntgen in the first instance. The Physical Society of London, in its abstracts of physical papers from foreign sources, classes all work with the Röntgen rays under the head of "Light," but upon very scant grounds. Numerous experiments have been made to test the character of these mysterious activities by the accepted criteria of light—namely, reflection, refraction, interference, and polarization—all results being negative, or so slight and uncertain as to leave them still open to question, and to make the name "X rays" not only the most common one by which they are mentioned, but the one best suited to express our knowledge—or ignorance—of their nature. Several attempts have been made to determine a length for them, supposing them to be waves, resulting in a supposed upper limit of length not greater than one hundredth that of violet light, and probably not greater than one three-hundredth. In the first few months of the furore of experimentation and discussion scarcely a result was announced by one observer that was not controverted by another; yet out of this very contradictoriness came a rational conclusion that at all events the rays are not homogeneous, but differ among themselves in their properties, as do the constituent rays of ordinary heterogeneous light. This would account for their non-interference. Of refraction there is as yet no evidence, nor, so far as known, is there any possibility of bringing the rays to a focus and thus producing an image of any object by means of them. All that can be done in that way as yet, as at first, is to obtain a shadow of varying intensity by reason of the various penetrability of different objects or portions of one object; and so the pictures thus produced are called by various names, as skiagraphs, radiographs, X-ray pictures, etc.—all chosen to avoid the idea that they are real light-pictures or photographs. Since

these shadows are produced by straight rays from a small surface, they are usually as large as the object itself, or larger. Many experiments were made to determine the source from which the rays proceed before it was learned definitely that they emanate from the surface upon which the cathode rays first impinge—a fact that was announced almost simultaneously by several experimenters. It is one of the important points that have been determined, and even this was distinctly intimated by Prof. Röntgen in the twelfth section of his original paper.

In intensity they vary inversely as the square of the distance from their source.

They electrify some bodies positively and some negatively, and whatever charge a body may already have they reduce or change it to the charge which they would independently give to the body. Their penetrating power depends upon the length of time they act.

Thus, gradually, these and many additional isolated facts have been established, and no doubt enough data will be accumulated eventually to permit generalization into laws; but that stage has not yet been reached.

Four theories have been suggested:

1. "They are ether waves, like ordinary light, but of exceedingly brief period, therefore ultra ultra-violet."

2. "They are streams of material particles."

3. "They are vortices of the intermolecular ether, forced from the cathode when the gas pressure is sufficiently low. Rectilinear propagation, absence of reflection, etc., follow from the properties of vortices."

4. "They are variations of stress in the dielectric surrounding the vacuum tubes."

Each of these theories is entitled to the Scotch verdict "Not proven," though the preponderance of opinion is on the side of the first. Still, it can not yet be said to be more than opinion.

Of the hundreds of papers that have been written during the year, the greater number have had reference to some special feature of manipulation, or detail of action of the rays, so that more has been learned of how to work with them than of their essential character. This has led naturally to improved apparatus.

It is well to keep in mind that the X rays do not make objects visible by their direct action, as light does. They do make certain *substances* self-luminous, causing them to emit a soft light of a grayish-blue or yellow or green color, depending on the nature of the substance, but this color is ordinary light, and not, at least to any considerable extent, the X rays. This luminosity, called fluorescence, is also excited in many substances by the ultra-violet or colorless portion of light, but the X rays are

especially strong in producing it. The substance employed by Dr. Röntgen was barium platino-cyanide, which is expensive. Experiment soon showed that other substances were more efficient as well as cheaper, hundreds having been tested under the rays for this effect. The best are tungstate of calcium, tungstate of zinc, barium platino-cyanide, and potassium platino-cyanide, the first named being at present the most common, though the last named has been a favorite with English experimenters. A screen of cardboard covered with a layer of fine crystals of either of these substances and exposed to the rays in a dark room, immediately lights up under their action, and a body impervious to the rays, when placed before the screen, is seen upon it as a shadow. If this screen is the front end of a light-proof box, into the other end of which the eyes can look while all light is excluded, we then have the fluoroscope, by which examinations can be made in a lighted room. Probably few X rays pass through and beyond the fluoroscopic screen. The effect of radiant energy upon a body is determined not by the rays that pass through it, but by those that are absorbed by it. It is difficult, therefore, to understand how the light which the blind have been said to see on peering into a fluoroscope can be really due to X rays.

The invention and improvement of the fluoroscope constitute an important part of the progress that has been made. The effect of the rays on photographic plates is heightened by similar means. The sensitive plate to be exposed to the rays is itself carefully inclosed in a wrapper so as to shut out every trace of light. If, before thus wrapping up the plate, a fluoroscopic screen is placed with its surface of crystals directly in contact with the photographic film, then where the rays penetrate to this crystalline surface it becomes luminous, and the light immediately affects the sensitive plate except in those spots where the object intercepts the X rays, and where consequently they do not cause fluorescence of the screen. This device has greatly reduced the time needed to obtain a photographic impression. Fig. 1 is an illustration of such action. A photographic plate was partly covered by such a screen, and the hand was placed partly over the screen and partly over the plate not covered by the screen. An exposure of twelve seconds was more than sufficient to produce a strong picture of the interior of the hand, under the screen, the flesh almost disappearing from view, while the effect upon the other portion of the plate (the dark part) is much less pronounced. The line of demarcation is very sharp.

Also photographic plates or films have been adapted to this particular use by preparing them so as to absorb the energy of the rays. X-ray plates are now used of which the mode of preparation is of course the manufacturer's secret, but which are

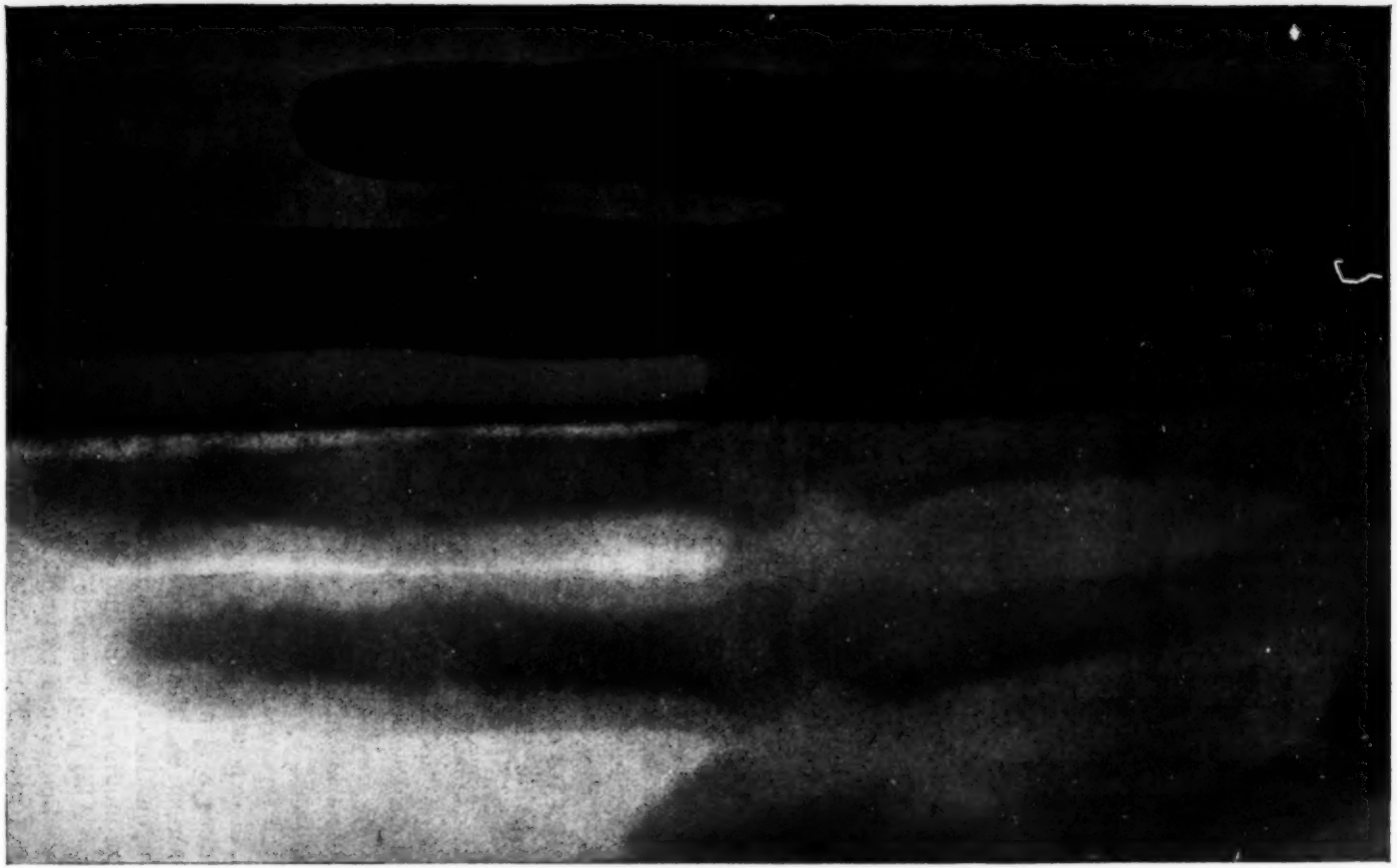


FIG. 1.—EFFECT OF FLUOROSCOPIC SCREEN. Exposure, twelve seconds.

coated with a very thick film apparently impregnated with some substance that fluoresces under the X rays. The time of exposure of such plates is less than with ordinary ones, though not much less than is required for a quick plate covered by the fluorescent screen, but the latter will not give the detail and differentiation of parts which are unequally penetrable by the rays that can be got from the X-ray plates.

The rays also affect sensitive paper, especially bromide paper, and now so-called X-ray paper is in use requiring even briefer exposures than plates. The picture on such paper is a negative—that is, shadows are light and parts affected by the rays are dark. Fig. 2 is an example of a picture taken on such paper, the objects being such as were greatly in vogue for the early pictures—a purse, a pincushion, etc. In the early efforts such a picture re-

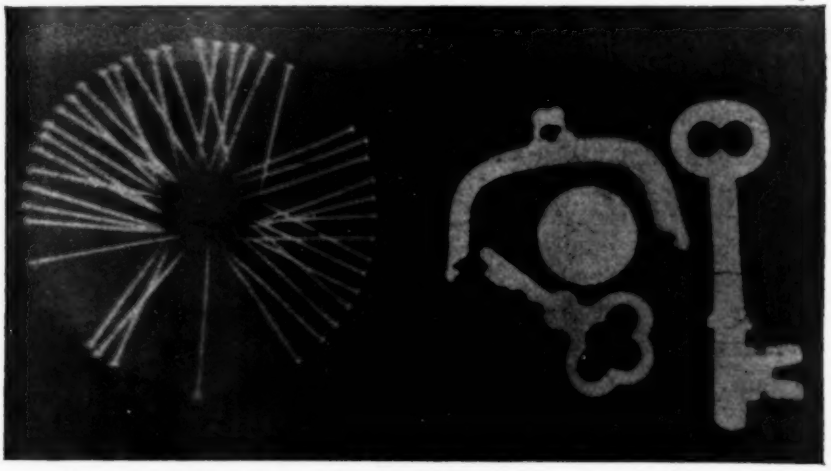


FIG. 2.—AN EARLY PICTURE REPEATED. Exposure, two and a half seconds.

quired fully twenty minutes' exposure to the rays; the example here was produced in two and a half seconds, or about one five-hundredth part of the former time. The writer has obtained a perfectly distinct picture of the same kind by a single fluorescent flash in the tube. That is practically instantaneous.

Fig. 3 shows the principal changes in style of tubes that have been approved. Nos. (1), (2), and (3) are forms that were to be found in most collections of Crookes's tubes in physical laboratories when the X rays were first made known. No. (1) was one of the earliest to give satisfactory results; then (2) was found to be preferable, and this "pear shape" was recommended as the most suitable form. Almost at the same time No. (3) was found to be particularly efficient. In this the cathode rays converge from a concave terminal upon a platinum plate used as an anode, such plate becoming the source of Röntgen rays proper. This

form was immediately developed into what was called a "focus tube," in which a similar concave focusing cathode was employed, and a platinum plate inclined at forty-five degrees to the axis of the cathode rays was inserted between the two electrodes of the tube to receive the impact of the cathode rays as in No. (4). A plate so placed is called an anticathode. This idea was carried still further to produce the double-focus tube shown in No. (5), which is especially suited to oscillatory discharges from the electrodes, and therefore adapted to use with alternating current apparatus, especially Tesla coils. In this form of tube the anti-

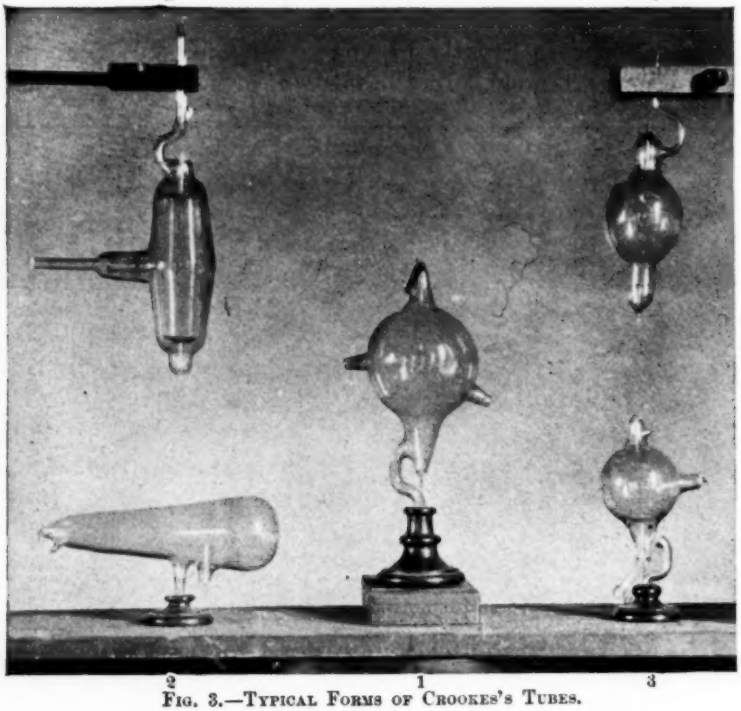


FIG. 3.—TYPICAL FORMS OF CROOKES'S TUBES.

cathode consists of a wedge-shaped piece of platinum midway between the ends of the tube. If this platinum terminal be connected with the positive pole and both end electrodes with the negative pole, this tube is very efficient with a Ruhmkorff coil giving unidirectional discharges. For any tube there is a critical degree of vacuum as well as electric potential, with which it is most efficient. Tubes can be made suitable for a coil giving a spark of not more than an inch, but they are not very energetic. Since the vacuum rises with continued use of a tube, some forms—e. g., No. (5)—have a small side tube communicating with the main bulb and containing caustic potash or other substance which volatilizes on being heated, so that its vapor will reduce the

vacuum. These are called adjustable vacuum tubes, and afford a means of controlling the requisite sparking gap of the coil within certain limits. Nos. (4) and (5) are now almost the only styles of tubes that meet with favor.

Three types of apparatus have been employed in exciting the X rays. All are necessarily such as are capable of producing a high electric potential, and all were in use prior to Dr. Röntgen's discovery. They are the Ruhmkorff induction coil, the plate influence machine (either the Wimshurst or the Töpler-Holtz), and the Tesla coil. The only development in these machines has been in some instances the improvement of their quality and enlargement of their capacity—without, however, introducing any novelty in the type of the apparatus, unless we except making the condenser of the induction coil adjustable in capacity. The most suitable rate of interruption of the primary current for each coil and tube may best be found by trial. Where a continuous current is supplied from a commercial circuit of a hundred and ten volts or more a rotating segmental wheel as interrupter with a rheostat in circuit is of advantage, but many experimenters get as good results by using a storage battery of six to ten cells, with an ordinary hammer break in the coil. The Ruhmkorff coil is used to give a unidirectional discharge in the Crookes's tube. Influence machines having several rotating plates act in the same way, and with excellent effect. Tesla coils are employed to give exceedingly rapid discharges to and fro in the tube, which require, therefore, two terminals that can both act as cathodes. It can not be said that either of these three forms is *per se* the best. With proper accessories one will give as good results as another, but the ordinary induction coil with suitable single-focus tube is the most generally practicable.

Fig. 4 shows an outfit of apparatus for X-ray use. It consists, in this instance, of a variable rheostat connected to one main of a hundred-and-ten-volt continuous current; in series with this is, next, a rotary interrupter, which is also driven by a current from the same main circuit; then comes an ammeter, then a pole changer or reverser, which connects back to the other main and forward to the primary of the large Ruhmkorff coil. This coil has in its base a condenser which is united with an additional adjustable condenser. There are, further, a double-focus tube, fluoroscope, and screen.

The most obvious suggestion of usefulness for the new agent was in surgery. It was so easy to discover any foreign substance in portions of the body, or to perceive the nature of any bony malformation, that it was hoped that surgery had received a valuable assistant in these rays. From time to time reports of successful operations based upon such revelations have been made,

but the early expectations were exaggerated. Methods of making examinations by these means have been so far simplified as to require no highly specialized knowledge for this purpose, and one would expect that hospitals, at all events, would be provided with an X-ray outfit if there is any advantage in it. Replies from a large number of prominent hospitals in six of the leading cities of America, which were asked concerning their employment of the X rays, showed that, of those replying, one third have such outfits; about one fifth have none, but expect to have one soon; and nearly half of those without such equipment have had examinations made for them. All that have used the rays testify to

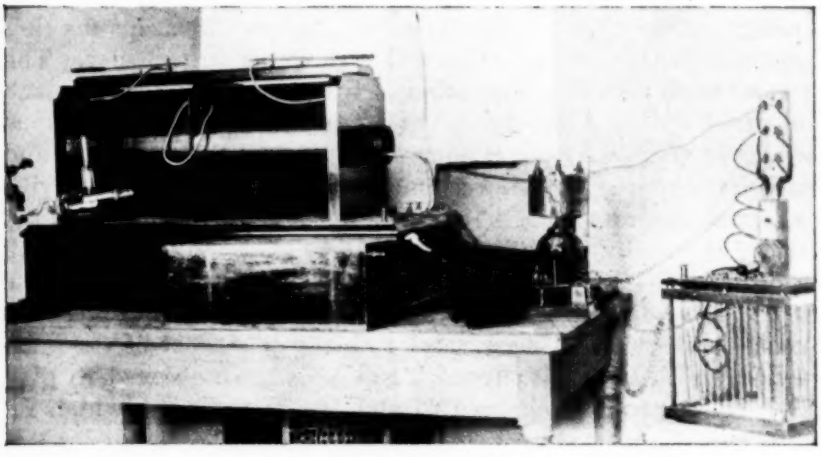


FIG. 4.—AN X-RAY OUTFIT.

their helpfulness, some of the physicians being enthusiastic over the method. Enough is told to show that the X ray is already an important aid to diagnosis, and, unless the future experience of the hospitals should be quite disappointing, such apparatus will soon be thought an indispensable feature of their equipment. The interior of the trunk, as well as of the limbs, has been successfully shown, the fluoroscopic revelation being immediate, while for photographic reproduction exposures of varying lengths of time are needed. The hand is the easiest member, requiring from five to thirty seconds, while the trunk requires half an hour or more. In general, it may be said that for pictures showing distinctions of structure, the time now required is from one hundredth to one fiftieth of that necessary at first. Pictures thus taken are being supplied to schools for the use of classes in anatomy and physiology.

THE BLASCHKA FLOWER MODELS OF THE HARVARD MUSEUM.

By MARCIA E. HALE.

THE Ware Collection of glass flower models in the University Museum of Cambridge is now so widely known and appreciated that a written introduction to it seems at first superfluous. Still, the fact remains that the interest and curiosity felt in regard to the history of the collection increase in proportion to its increasing fame.

Among the vast number of people who visit the exhibition rooms of the botanical department of the museum there must be few who do not feel on leaving that a revelation has been disclosed to them. The *savant* finds the rendering of the minutest details of vegetable organism almost inconceivably accurate, while the general public can hardly fail to derive from the beauty of these models an awakening interest in the mysteries of plant life.

Before considering the scope of the collection it might be well to examine the nature of the models themselves.

To the casual observer it seems almost incredible that these sprays of leaf and blossom—these magnified details of flower and fruit, true to Nature not only in form and color but also in texture—that these models before us should be made of glass. Not even the daintiest productions of the Venetian and Bohemian glass workers have prepared us for the delicacy and pliability which we find here, and it seems hardly necessary to state that the process employed in making these models is in no sense that of ordinary glass blowing. From the simpler methods of making window glass and bottles to the artistic fashioning of such work as this is a wide step, and it may be interesting to sketch incidentally a brief outline of the history of glass making.

The origin of this art, unlike that of pottery, seems to have spread from a single center, instead of having been discovered by different nations independently. The early history of the art is shrouded in the dim mists of tradition, but the ancients seem to agree in giving the credit of the invention to the Phœnicians.

The story is too well known to need repetition of the party of Phœnician merchants who, having kindled a fire on the banks of the river Belus, proceeded to cook their dinner in pots supported by blocks of niter (carbonate of soda) supplied from their stores, in place of the stones which this sandy region did not furnish. Under the heat of the flames the fusion of the alkali with the sand produced glass. Thus far tradition. The earliest known specimens of glass, however, are Egyptian, and there may be

seen in the British Museum a small lion's head of blue-green glass found at Thebes, which is probably the oldest specimen extant.

Under the Egyptians the art developed in all its details. They knew how to melt, color, and carve it.

The Greeks, too, used it, and many beautiful medallions were made from it by them. By far the greatest number of specimens of ancient glass preserved to us are Roman, and many quaint cups, vases, and images in both public and private collections attest the skill of the Roman glass workers. Pliny gives many curious details in regard to the glass making of his time, and mentions the invention of mirrors. He also speaks of the manufacture of glass in Italy from "a sort of sand found on the banks of the river Volturno," and adds that the same process is used in Gaul and in Spain.

Many of the Gallo-Roman cemeteries have yielded treasures of cups, necklaces, and tear bottles, iridescent fragments in which the metallic reds, blues and greens, still keep their original splendor. For many centuries it was supposed that the secret of this prismatic luster was lost, but modern glass workers have succeeded in reproducing or at least in approximating it.

One might dwell at length on the gradual development and perfection of this wonderful art were it not that space forbids and that its course has been traced by abler pens. Let us, then, touch only on the Venetian fabrications, which seem to have had their origin somewhere toward the fifth century, when the Venetian population, hunted and persecuted by barbarous tribes, sought refuge in the seclusion of the lagoons. Here in unmolested peace they pursued their work, into whose mysteries they had been initiated perhaps by the Egyptians or the Phœnicians, and to which their own skill and artistic sense lent much. It was not until the middle of the thirteenth century that the city regulations, fearful of accidents from fire, compelled the glass makers of the Rialto to establish themselves on the island of Murano, at a safe distance from the homes of men. Since that time the name of this little island has been closely associated with the production of exquisite objects which seem to embody in their fragile forms the transparent clearness or opalescent tints of the waters of the Adriatic.

Strange stories have come down to us of the vigilance with which Venice guarded the secrets of her delicate handicraft. Throughout the intricately woven, many-colored web of her history runs the thread of her glass-makers' chronicle, like the gleaming lines of gold which intermingle on some fantastic Venetian goblet.

In the thirteenth century a fresh impetus was given to the

art by the Venetian traveler Marco Polo, who brought home reports of the demand among Eastern nations for imitation gems, especially pearls, and these were consequently made in vast quantities for exportation.

Not all her jealous care, however, could prevent the art of Venice from spreading to other countries. The makers of these flower models of the Ware Collection claim that their ancestors brought from Venice to Bohemia the secrets of their craft. Be this as it may, Bohemia was the next country to manufacture glass, and the Bohemians introduced a new decorative system, that of engraving glass. To this succeeded the art of glass cutting and of luster making as well as that of painting glass.

Germany, France, and Belgium were not slow to follow Bohemia, and in each country new processes and new decorative ideas were developed. Thus the manufacture of glass spread throughout the civilized world.

To come down to the personal history of the artists in question, Leopold Blaschka was born in 1822, in Aicha, a village of northern Bohemia. His father, Joseph Blaschka, was not only a skilled glass worker, but was also an able mechanic and electrician.

After his early education in the grammar school of his native town, Leopold Blaschka was placed in the studio of the painter Elsner, with whom he studied for some time. At the same time he acquired from his father a thorough knowledge of the goldsmith's trade, becoming expert in the cutting and setting of gems and in gold and silver work—a knowledge which he put to a practical use in the manufacture of fancy articles for exportation.

From childhood, however, he had felt an absorbing interest in natural history, and when in the interest of his business he made a voyage in a sailing vessel to America in 1854, he found ample opportunity during a calm at sea to make many studies and drawings of marine invertebrates. On his return he began what proved to be his life work—the modeling of plants and animals in glass.

Some of these earlier models came under the notice of the botanist Prince Camille de Rohan, for whom Blaschka made a collection of about sixty orchids in glass. These were first exhibited in Prince de Rohan's palace in Prague in 1862. They afterward came into the possession of the museum at Liége, where they were unfortunately destroyed by fire in 1863.

Certain annoying circumstances connected with one of these earlier collections, together with the fate of the Liége models, gave Blaschka a distaste for this branch of his work, which he abandoned forthwith, devoting himself exclusively to the manufacture of animal models.

In this work he was assisted by his only son, Rudolf, who was born in 1857, and who became, in 1870, his father's associate in his work. He was the only apprentice whom the elder man initiated into the mysteries of his art—the only person, therefore, since the death of Leopold Blaschka, in 1895, who possesses the secret of these marvelous productions. Both father and son were diligent and careful students of zoölogy, and their accurately rendered models met with a ready sale for museums throughout the world, the most complete of these collections being perhaps that which was purchased by the Harvard Museum of Comparative Zoölogy.

In 1885 the privilege of constructing for its own use the central portion of the University Museum at Cambridge was offered to the Botanical Department by Mr. Alexander Agassiz, who has carried so far toward completion his father's plans for a Museum of Comparative Zoölogy. Through the advice and cooperation of Mr. Agassiz, and through the untiring zeal and energy of Prof. George L. Goodale, who succeeded Dr. Asa Gray in the Fisher Professorship of Natural History, the large sum necessary for the construction of the building was obtained by subscription, the result being a most satisfactory structure which furnished ample space for laboratories and for exhibition rooms in which to display illustrations of all the chief types of plants. It was now necessary to provide these illustrations, and no means hitherto employed seemed wholly adequate to the desired end.

Flowers in all known states of preservation are apt to lose both color and character, and to become unsightly as well as uninteresting. Even if accurately represented by colored drawings, something is still wanting, as they must fail in expressing at least one of the dimensions of space. Gelatin seemed too perishable a substance to be used, *papier-maché* was hardly desirable, and the idea of wax models was altogether distasteful. It was a happy inspiration of Prof. Goodale's when one day studying the beautiful glass models in the Zoölogical Museum which led to the solution of the problem. If these marvels of the sea could be copied in glass with such beauty and fidelity, why should not the same medium be employed for the models of flowers?

Acting promptly upon this suggestion, the next step to be taken was a journey to Dresden for the purpose of making the proposition to the artists. At first Dr. Goodale's trouble seemed likely to prove useless, for he found the Blaschkas most unwilling to abandon the making of animal models, which occupied all their time, and for which there was an unfailing demand.

Up to this time, Prof. Goodale had never seen any glass flowers made by the Blaschkas, and it was during this first visit to their home at Hosterwitz, near Dresden, that his attention was drawn

to a vase of orchids, apparently freshly cut, but whose freshness proved to be perennial, since they were the work of the elder Blaschka, who had made them for his wife some twenty years before this date! During all these years the flowers had stood uninjured from exposure to the air and dust of the room, though without even the protection of a glass shade. Here was a convincing argument in favor of glass models for the Harvard Museum.

After much consideration on the part of the Blaschkas, they consented to undertake, on their own terms, the preparation of a certain number of models.

In consenting to this, Leopold Blaschka was strongly influenced by his wish to afford his son further opportunities for carrying on his studies in botany, a science to which he had given much attention; another potent factor in gaining his consent being the kindly sentiment he had cherished for America since his early voyage to that country.

Feeling that he had accomplished the first and most important step in his mission, Prof. Goodale returned to America, and in the autumn of 1887 the first consignment of flower models reached him—shattered to fragments in the New York Custom House, whose inspectors had done their work "not wisely but too well!" The fragments were, however, sufficient to show the quality of the models, and to inspire much enthusiasm.

Among the first to appreciate the excellence of the models, both from an artistic and a scientific point of view, were the two ladies who later became known as the donors of the collection. At first, by their own wish, their names were not connected with the enterprise, which afterward took the form in which the public now recognizes and honors the collection—that of a beautiful and lasting memorial to a graduate of Harvard University, the late Dr. Charles Eliot Ware, of the class of 1834. Each successive step toward the accomplishment of this purpose has been attended by the happiest results, and no element has been wanting to give completeness to the collection.

The second consignment of models arrived, passed safely through the perils of the custom house, and proved satisfactory in every way.

The undertaking hitherto had been a personal experiment of Dr. Goodale's, and he has had from its very inception the entire charge of it. Under the new conditions new contracts became necessary, the final one of which, executed at the consular office in Dresden in 1890, engaged all the time of the two Blaschkas, thus securing a fixed number of models to be sent in two consignments each year, until the collection is completed. The time necessary for this completion is at present uncertain, owing

to the death of Leopold Blaschka in July, 1895, since the work now falls wholly on his surviving son.

One of the questions asked most often is whether there is no one besides Rudolf Blaschka who can make these models, or who can at least assist him in making them.

When the nature of the work is investigated, it becomes evident that the only answer to this question is a negative one. This is due, not so much to the existence of any one secret connected with the production of the flowers, as to the fact that they are the result of the keenest artistic perceptions, and of absolute scientific accuracy, combined with a wonderful delicacy of manipulation, and also with infinite patience! That the family possesses certain technical secrets is not to be denied; and not only these hereditary secrets, but many new devices of the art have been called into requisition by these two wonder-workers in whose hands the brittle substance has assumed a plastic character. It is not glass *blowing* but glass *modeling* which has produced these marvelous imitations of Nature. Glass of all degrees of fusibility has been used in their composition, and the colors have been subjected to many experiments: some are imparted to the glass while fused, some while cooling, and some are applied afterward. All the pigments used are mineral colors, as an attempt to supplement these with aniline tints failed utterly.

During the lifetime of the elder Blaschka, the father and son were inseparable in their work; no one step, however slight, was taken by the one without first consulting the other. They worked at the same table, and Prof. Goodale, who alone has been privileged to see the process, confesses himself even more puzzled by their rapidity and skill after seeing the work than before!

The highest degree of excellence, too, has been attained in the use of cements and in the method of securing the models to the tablets; the reproduction of the widely different textures of leaf and petal is a marvel by itself, and such perfection can have been reached only by infinitely painstaking experiment and study. All these matters, as may readily be seen, are not easily acquired or imparted, and for these reasons the collection seems likely to remain, as it is at present, absolutely unique. The artists have been given every opportunity and advantage in the way of plants for study. A photograph of their pleasant home in Hosterwitz shows a large but unpretending house, surrounded by a garden in which American plants are grown. The Blaschkas have had the benefit, too, of the Royal Gardens at Pilnitz, the summer home of the court of Saxony, which is situated on the Elbe within a mile of Dresden.

The Blaschka house contains two studios, in which the models of the Ware Collection are exhibited to a number of invited guests

before each consignment is sent to this country. The method of packing is in itself interesting, so carefully are these fragile treasures prepared for their long journey. Each model is secured to its tablet by means of fine wire, then the tablet is fitted into its pasteboard box; under every curve of stem and tendril, supporting each leaf and petal, wherever there is space for it between tablet and model, are soft folds of tissue paper. More of the same paper, lightly crushed, fills the box to the brim, the cover is fastened on, and the boxes are then placed in a strong wooden case, which is in turn embaled in straw and finally enveloped in coarse sacking. It may readily be imagined that the task of unpacking is an equally delicate one, and it is a proof of the skill with which both processes are accomplished that so few of the flowers have suffered in either.

Rudolf Blaschka has made two visits to America in search of subjects for models—the first in 1892, when he made a journey to Jamaica in order to study subtropical plants, as well as one to Arizona and California, returning by way of Colorado and the nearer Western States. These journeys yielded rich results in the way of sketches and studies, which were for the most part rapid pencil drawings made from the living plant, with only slight washes or crayon touches of color, Blaschka's minute memoranda furnishing all further necessary detail.

The second trip to America was made in the summer of 1895, and from this expedition Rudolf Blaschka was recalled by the sad news of his father's death.

The original plan of the collection had been to represent only the flora of North and South America, as it had seemed doubtful if the services of the two artists could be secured for a longer time than would be necessary for this. After beginning to make models of flowers, however, the Blaschkas had found their old work of making marine animals, which must be duplicated, extremely distasteful, and had signified their willingness to devote themselves wholly to the new enterprise, which they evidently wished to be considered their monumental work.

From the very beginning of the undertaking, both father and son have acted from the highest principles and with perfect integrity, and the relations on both sides have been of a most cordial and pleasant nature.

All subsequent offers, no matter how advantageous they might appear to be, have been steadfastly declined by them; and that the contract has been fulfilled, not in the letter alone, has been ably proved by the evident fact that the flower models have, if possible, shown greater excellence in the later than in the earlier instances.

So greatly has the proposed scope of the original scheme been

enlarged, that it now seems probable that five or six years' time will see illustrated by this collection all the great types of plant life throughout the world, all except eight of these types being represented among the plants native to North or South America. Already more than one hundred orders are represented, and here it must be clearly understood that no attempt has been made to show every *species* of plant. This would indeed be an impossibility! Not more than six or seven species of an order are given, but the collection thus illustrates a large proportion of the genera. Certain tablets, prepared for demonstration, exhibit a larger number of details than others; sometimes several species of a genus are shown, in order to emphasize the more or less strongly marked variation of certain characteristics, but in general the aim has been to show the typical species of different genera.

The three exhibition rooms are so arranged as to illustrate plant life in all its relations, from a biological point of view. The models are displayed in admirably constructed cases of plate glass and bear labels giving the names of the plants as well as other details in regard to them, thus offering every opportunity for study. The first room or hall, which one enters from the staircase, is intended to show plants in the following relations:

1. In relation to soil, water, air, heat, light, electricity, and gravitation.

2. In relation to insects and other animals by which plants are benefited.

3. In relation to insects and other animals by which plants are injured.

4. The relation of plants of the past to plants of the present time.

Here are also seen the plants used as forage.

The room on the left of this hall represents the Department of Economic Botany. Here we find illustrated plants in their relation to man—i. e., the plants used for shelter, clothing, and food; then those used for drugs, dyes, etc.; and here also are the plants of historic interest.

In the third and largest room the lower floor is devoted to flowering plants (by far the greater proportion of the collection), while the balcony contains the illustrations of cryptogams. In regard to the quality of the work, it is hardly possible to speak too highly. The mastery of color alone is marvelous, but when we appreciate the fact that the most minute detail of the tiniest flower, even to the starlike hairs on the sepal of a calyx, will bear the scrutiny of a microscope, words fail us in which to express our admiration for the creative power of these artists. The closer the study the more extraordinary seems the fact that the material employed for these models is glass! As in Nature no two flowers

or leaves of a single plant are exactly the same, so in the glass reproduction every infinitesimal variation is rendered with a fidelity which is almost painful. A distinguished local botanist has made a test of this accuracy by selecting at random a number of specimens from various orders and submitting them to the lens. In one of these examples, that of *Aralia spinosa*, L., he counted nearly eight thousand buds and flowers, some of the former so small as to be indistinguishable to the naked eye, while every flower was yet found to be complete even to the number of petals and stamens. The same exactness is shown in the large compound leaf of this plant, even in the under surfaces, which are hidden from the eye of the observer by being turned toward the cardboard on which it rests. The result, as may be imagined, is simply unequaled, and one hardly knows whether to give the greater credit to the genius which inspired such work, or to the conscience and patience which have made its execution possible. Let us linger before one or two of the object lessons taught in the economic room. One of the most complete studies is that of the Indian corn (*Zea mays*). Here we find, first, the glass model, a stalk of corn from two to three feet in length, showing the long, wavy-margined leaves, the tasseled flowers, and the developed ear in its infolding wrappings of husk and with its delicate plume of "silk." The magnified details in this instance give a single flower, a stamen, and a single grain of maize in its development from the flower. On a shelf above the models, but still in the same case, are displayed dried ears of ripe corn of all sizes and varieties, from the tiny pop corn to the largest and most highly cultivated product of the market garden.

Next these are arranged glass jars containing the articles of commerce prepared from corn: here are corn meal, hominy, bran and cattle feed, corn oil and oil cake, starch in all its forms, climax sugar, anhydrous sugar and caramel, American and British gum, dextrin, mucilage, and whisky.

A beautiful specimen is that of the nutmeg (*Myristica fragrans*), one spray of which gives the amber-tinted flowers in their small, axillary clusters, while another branch shows the ripened fruit. There is also in glass a thin section or slice, showing the nut in its surrounding aril which forms the *mace* of commerce, and the enveloping husk outside this again.

A number of small, open boxes hold various kinds of nutmegs, some from India, some from Java, and there is even a *wooden* nutmeg to complete the collection!

The exhibit which seems to awaken perhaps the most popular interest (at least among the children, who visit the museum in throngs) is that of the chocolate tree (*Theobroma cacao*). The beautiful glass reproduction is interesting enough in itself, as

it shows the way in which the flowers and fruit grow from the old wood instead of from the young twigs. From a section of woody trunk or branch, perhaps two inches in diameter, spring the delicate pinkish flowers on their threadlike crimson pedicels. They grow in clusters of three to six, and the effect of these little galaxies of pale stars against the dark background of bark is very charming. The model shows, too, a spray of the glossy green leaves, and one of the ripened orange-colored fruits. Photographs beside it give an excellent idea of the growth of the plant in Central America and Jamaica, and accompanying the prepared products are printed slips containing the desired information—as, for instance, that "chocolate consists of the roasted seeds of the cacao freed from their shells," or that "cocoa is made from the roasted seeds freed not only from the shells but from the excess of oil." Here, in the glass jars, are many varieties of the cocoa seeds and of chocolate pods preserved in alcohol. Here, too, we find both raw and roasted cocoa from Trinidad and Carácas, from Santo Domingo and from Ceylon, from Surinam and from Bahía. Among the finished products are cocoa shells and breakfast cocoa, chocolate of all grades, and cocoa butter.

This slender stalk of blue-flowered flax seems a fragile wand to wield such widespread power until we study its manifold products and comprehend its range. Contributions have come from all lands, from Friesland to China, and we see them in all stages of manufacture. With the model of the cotton plant are some seed capsules from one of the Southern States; and here we find a set of the standard types of cotton arranged in boxes and presented by the Classification Committee of the New York Cotton Exchange.

In the larger room the flowers are arranged in close accordance with the accepted synopsis of orders. Of course, in following this method of classifying the models, little attention could be paid to the juxtaposition of colors, yet at the same time one is impressed by the admirable harmony of these kaleidoscopic tints.

This harmony may be in a measure due to the large proportion of white flowers, as well as to the perfection of color and texture shown in the foliage.

The shades of red rank next the white flowers in number, then come the yellows, and last of all the blues, with their gradations of purple, lilac, and lavender. The distribution of color seems to bear no relation to the conditions of climate or of soil, though we find that certain species grown in the German garden of the Blaschkas have deviated slightly from the colors which the same flowers wear in our own fields and forests; the Mayflower (*Epigæa*), for instance, seems paler and less vigorous and the wild geranium of a more intense shade than with us; but we may be

sure that the models are absolutely true to the subjects furnished for them, wherever they were grown.

It is interesting to make a study of several species of a single order, noting at the same time the typical characteristics and the variations of detail. Take, for instance, one of the most common and easily recognized orders—that of the *Malvaceæ*. Here we have no less than eight species, representing six genera. They are: *Hibiscus clypeatus, Hibiscus palustris, Spheralcea acerifolia, Sida carpinifolia, Sida napæa, Nuttallia malvæflora, Anoda Dilleniana,* and *Malva miniata.*

All these species show the distinguishing characteristics of the family—the translucent texture of the petals, with their clearly marked veinings; the delicate tints of the corolla, varying from white to deep rose-purple, or, as in the case of the *Sidas,* to a tawny, crimson-throated orange. All have certain enlarged details in which we again easily recognize the distinguishing features of the order—the column of stamens, the peculiarly shaped anther (in the example of *Hibiscus palustris* shown in two stages of its development, while an immature anther of *H. moscheutos* is given), the style with its capitate stigmas, and also both longitudinal and cross sections of the ovary showing the arrangement of the ovules in their cells.

In *Spheralcea acerifolia* the inflated, heart-shaped anther is speckled with pale red like a bird's egg, and here we have also a pollen grain magnified one thousand times. Among the details of the *Nuttallia* is a sepal with its stellate hairs and a single one of these hairs enlarged two hundredfold and looking like a tiny snow crystal. Probably none of the models illustrate better the value of these magnified details, in studying the more recondite orders, than those of the *Euphorbiaceæ,* where the inflorescence owes its beauty to a highly colored involucre, while the flower proper is reduced to a single organ. So in *Jatropha officinalis* the brilliant, flame-colored involucre attracts the eye, while the insignificant flower is represented by a solitary stamen or pistil. The three-celled ovary, the three styles each with its two-cleft stigma, may here be carefully studied without recourse to the aid of the lens. Especially delicate is the little *Euphorbia montana,* gray as if with the dust of the California deserts it comes from. A detail of the inflorescence shows the inner side of the involucral bract to which the sterile flowers or stamens are attached.

Still another plant of the same order is most baffling to the student, from the arrangement of the pale pink flowers on the margins of what appear to be flat, cactuslike leaves, but which are in reality the rudimentary branches of this curious growth; this is the *Xylophylla Roezlii.*

One might spend weeks over the exquisite *Compositæ*, whose examples are incomparable. Here, again, the aid given by the enlarged details is incalculable, and it is delightful to be able to study the infinite variations of the multitudinous florets without the microscope. Let us note the difference of detail shown in three species of a single genus. Here are the three *Encelias* —*farinosa, canescens,* and *eriocephala* respectively—California plants with what might be described as starry, yellow flowers, all much alike in the careless eye of the amateur botanist. Each of the three species shows in detail a single floret enlarged from ten to twenty times, and also one of the surrounding ray flowers. In studying these we begin to find in what respects the flowers do *not* resemble each other.

E. canescens shows the receptacle and a chaff scale, varying in form from that of *E. farinosa,* a scale of the involucre with its silvery hairs and the fruit magnified ten times.

In the third species (*E. eriocephala*) the color as well as the form of the floret differs from those of the first-named species—the yellow, tubular floret with its protruding pistil deepening to a warm brown, thus giving to the crowded head of flowers the appearance of a dark, velvety disk amid the surrounding rays of a brilliant yellow.

The foliage, too, of the three species shows a marked distinction in coloring, that of *E. canescens* being of a rich warm green, which in *E. farinosa* changes to a glaucous blue-green, while in *E. eriocephala* both stem and leaves assume a downy texture.

The *Asters* and *Erigerons* are wonderfully perfect, from the young buds showing only the involucral scales or the tips of the closed ray flowers, to the matured flowers in which the discoid florets are fully opened, while the rose or purple rays curve inward as they fade.

Such plants as *Bromelia pinguin* and *Ananassa sativa,* together with the *Cactaceæ,* demonstrate the impossibility of rendering these plants satisfactorily through any other medium than the glass used here. The heavy flowers of the *Opuntias* and the *Cereus,* their fleshy stalks and spiny leaves, are too substantial to be satisfactorily preserved either in alcohol or by drying. In the glass model we seem to see the living plant.

The barbed leaves of the *Bromelia* keep their free outward curve as if to defend from trespassers the strong, club-shaped spike from which spring in spiral ranks the pink-purple flowers, each in turn protected by a flower sheath tipped with fierce scarlet. The whole plant has a martial aspect—it is a warrior, and a dried specimen of it would fail to give any idea of its true character.

The *Orchids* might be dwelt on at great length did space per-

mit, but here, again, all are so exquisite that it is difficult to make a choice. Equally fine are the golden butterfly-plant from Trinidad, the spiderlike, black-barred *Brassias*, the beautiful blue and white *Cattleya crispa* with its crimped edges, and the lustrous rose-tinted *Cattleya amethystina*.

New beauties appear at every step. *Convolvuli* and starry *Ipomeas* fling their light garlands across their cardboard tablets, as if feeling for some trellis to wind about; the pimpernel opens its little red weather-glass of a flower; the dainty sundew catches the light in its tiny diamonds; the Venus's flytrap shows the unwary victim caught in its fatal leaves.

In the gallery overhead are the cryptogams—plants whose nature renders them difficult subjects for illustration. The utmost care has been exercised here in selecting the types which will prove of the greatest use, and there will probably be added from time to time the examples most needed. It is intended to present the lower forms of plant life in a well-chosen series of types from motile protoplasm, fungi, and algæ, through mosses, club mosses, and liverworts to ferns. These models are quite as wonderful in their way as those of the flowering plants, if less interesting to the general public. Among the ferns an *Adiantum* shows in its magnified details the entire process of reproduction, from the tiny spores to the young fern with developed rootlet and frond.

No written description of these models can give an adequate idea of the immense service rendered to science by them; to appreciate this it is necessary to study the collection in all its length and breadth.

Considered in the light of a memorial, we need only say it is worthy of the earnest life it commemorates. The bronze tablet on the wall, beautiful in its simplicity, bears the following inscription:

MDCCCXIV MDCCCLXXXVII

IN MEMORIAM
CAROLI ELIOT WARE
MEDICI
HUJUS UNIVERSITATIS ALUMNI
HASCE IMAGINES
DONAVERUNT
CONJUX ET FILIA SUPERSTITES
RURA FLORES AMICUS EX ANIMO COLVIT
VALDEQUE DILEXIT

MARVELOUS stories are told, according to Mr. St. George B. Littledale, by the natives of Keria, near Khotan, of the gold and precious stones they dig up from the ruins of cities buried in the sands. They make regular expeditions into the desert to recover the lost treasures, and come back telling of fortified cities guarded by ancient men in quaint Chinese costumes, speaking an unknown tongue.

THE CLIFF-DWELLER'S SANDAL.

A STUDY IN COMPARATIVE TECHNOLOGY.

By OTIS T. MASON.

ONE of the commonest elements in any picture of modern Latin America is the *cargador*, or porter. Upon his back may be seen water, merchandise of every sort, in curious receptacles, supported and held in place by a strap across his forehead or across his breast. His dress also is the quaintest mixture, partly old, partly new, of the primitive aboriginal and of the later European cut and stuffs.

CHASQUE RUNNER BETWEEN CHILILAYA AND PUNO, PERU, WEARING SINGLE TOE STRING. (Wiener, *Pérou et Bolivie*, Paris, 1880, p. 593.)

But at present we are concerned with his feet and their gear. Underneath is a sole of hide, harness leather or sole leather as the case may be, cut in the form of the foot and having a hole through the front and gashes through the margin just beneath the ankle. About the foot is the lacing, consisting of a narrow strap knotted at one end, drawn up through the hole in front between the first and the second toe, then carried over the back of the foot through a side gash, where it makes a half hitch, then backward over the heel to the other gash, making another half hitch, thence over the instep, where it is tied into itself to complete the round. There is another style in which the toe string is omitted, a cross lacing over the top of the foot and above the heel like that on a west coast baby frame, holding the sole to the foot. There are many varieties of these types, as may be seen in Wiener's *Pérou et Bolivie*, pages 676–681.

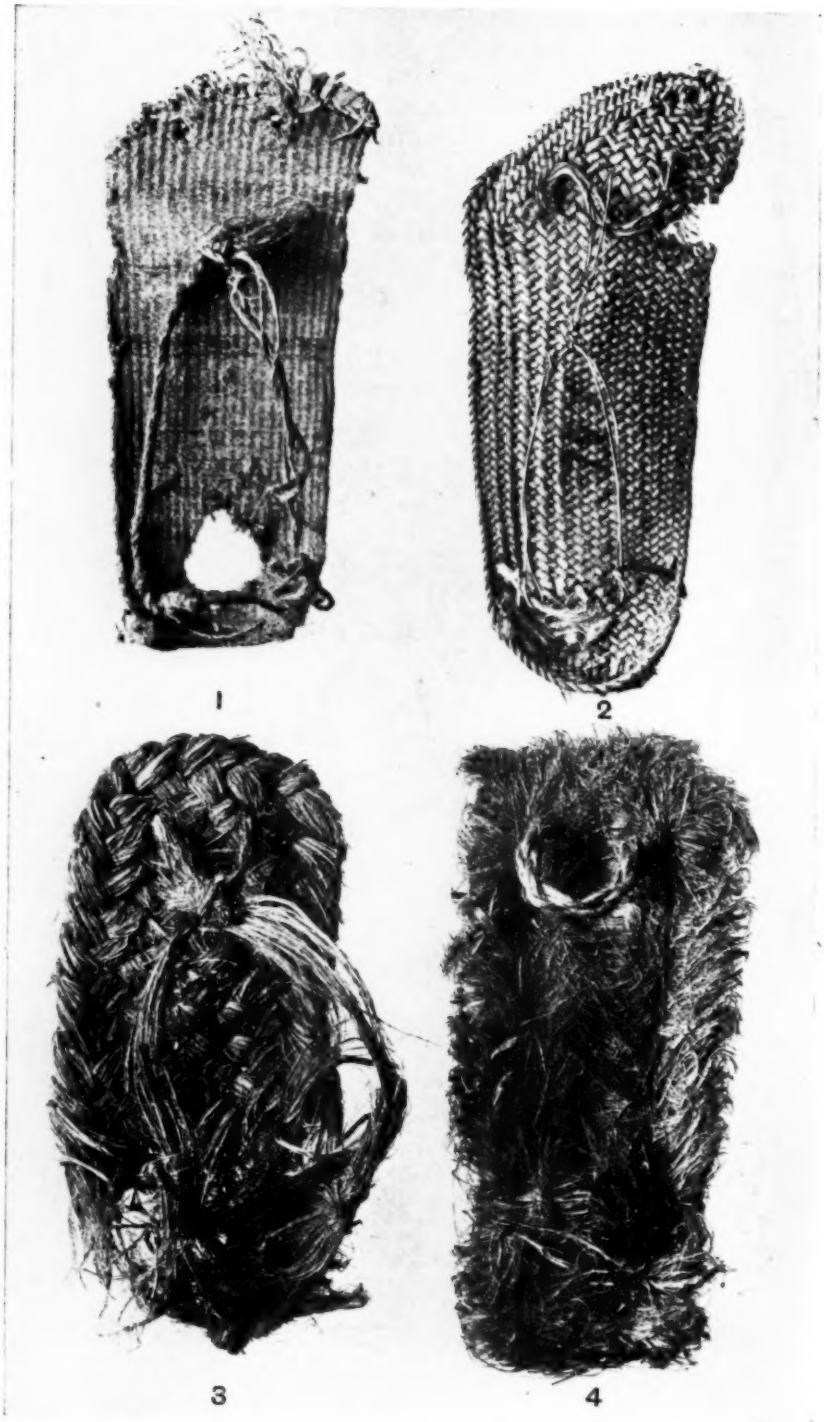
The geographical and chronological distribution of the sandal first named is most suggestive. So far as the National Museum collections teach, this form occurs throughout the Japanese area, but nowhere in Korea or China. By climate it is debarred from Manchuria, Mongolia, and all Siberia, and it is not seen in Tibet.

But both the Japanese type of sandal and the divided mitten-like sock occur again in Kashmir and countries westward and southward. Thence this sandal is found in southern Asia, and has walked all about the Mediterranean for thousands of years. It was the footgear of the Melanochroic Caucasian from very early times. The Mohammedans have scattered it here and there in Africa and thence wore it into Spain. The Latin peoples that conquered middle and South America introduced there for the first time in the history of the Western world this sandal with the single toe string.

Before that there were in America fur boots in arctic areas, buckskin moccasins down to the borders of the arid region, and thence southward the foot was protected by a sandal, not of rawhide, for there was none in existence, but of fiber in various kinds of plaiting, and kept on the foot by lacing all round the border and by toe strings and toe loops inclosing toes No. 2 and 3. Fortunately, the meager collections from the cliff dwellings in the United States National Museum are abundantly supplemented by the materials in Cambridge and in the University of Pennsylvania. Through the courtesy of Prof. Putnam and Mr. Stewart Culin I am able to say that the ancient sandal of Arizona and New Mexico never had the single toe string between toes No. 1 and 2. The old types were either of rawhide slashed about the margin, or of fiber with loops about the margin, or of fiber with strip or loop inclosing toes 2 and 3. The examples shown in the plate are from the cliff dwellings of Arizona. Fig. 1 is in the basketry stitch of northern California, "twined work" on a warp of yucca twine in two layers; the weft of *Apocynum* is treated precisely like that of the Ute, Apache, California, and some mound-builder fabrics, by twining two filaments about the warp strands. Decorations are inserted by varying the color and the overlapping of the warp. The lacing is better shown in the next example.

Fig. 2 is of *Yucca angustifolia* fronds not shredded, but plaited diagonally in the manner most widely spread over the Western world. The lacing consists of toe loop, heel loop, and string. The last named commences on the instep and is looped about the toe loop, the heel loop on the right, over the instep and about the heel loop on the left, back to the starting point and knotted.

Fig. 3 is of coarser yucca fiber shredded somewhat, and plaited more coarsely than Fig. 2. The lacing is on the same plan as in



1

2

3

4

Fig. 2, but the knots are all at the toe loop, and the entire lacing is in one piece.

Fig. 4 is quite different from the other three, and is practically woven on four coarse warp strands, by wickerwork, the thick ends of the leaves being left on top and shredded to form a soft bed for the foot. The toe loop is as in Fig. 2. Many sandals of eastern Asia are woven on the same plan, the long ends of the warp being left underneath next to the ground.

INDIA RUBBER AND GUTTA-PERCHA.

By CLARKE DOOLEY.

WAS India rubber known to the ancients? Early writers do not mention it. We need not necessarily conclude, however, that the primitive peoples established on the shores of the Mediterranean were ignorant of the existence of this substance. The game of tennis is one of great antiquity, Herodotus attributing its invention to the Lydians. It is believed they got it from Egypt, which may have received it from Ethiopia. It is known that India-rubber trees are found in Abyssinia to-day. Hence it is reasonable to suppose they were indigenous there in earlier times, and that the inhabitants knew how to prepare resilient balls from their milky product. The Chinese have laid claim to the discovery of rubber, but have so far been unable to prove that they were the first to employ it. Modern Europe had no knowledge of it until the discovery of America. The Spaniards were much surprised to find the Indians playing tennis with balls made of a strange substance which excited their attention, as mentioned by Fernandez de Oviedo at the beginning of the sixteenth century.

This remarkable substance is obtained from the milky juice of certain trees and different varieties of climbers. South America is the principal source of supply—Brazil, of the many states producing it, leading in quantity and quality, and having in its great forests sufficient to meet twice the wants of the world. The best is Pará (fine, medium, and *sernamby*), from the great basin of the Amazon, where more than eighty thousand *seringueiros* (gatherers) are engaged in the dry season in collecting gum. White Pará, "virgin sheets," a new variety in three grades, comes from Matto Grosso. Since its importance first began to be felt, this gum has exerted an increasing influence upon the spread of civilization, especially along the Amazon and Orinoco and their tributaries and the great streams which pour out from the interior of the Dark Continent. Pará, formerly an insignificant village, has

grown to be a city of a hundred thousand inhabitants, with modern features, and Manáos, up the river, is fast following it. India rubber is the mainstay of the northern Brazilian states, Bolivia, and eastern Peru. Brazil has a great advantage in its immense waterway; ocean-going steamers run twelve hundred miles up the Amazon, whereas every African river except the Congo has a bar at its mouth and cataracts not far distant from the coast line. It is, besides ivory, about the only commodity produced in the interior of a tropical country that will bear the expense of transportation, often on the heads of natives along tangled man-paths, to the seaboard. So in many places it has been the basis of first commerce. The principal trees in South America are the *Manihot Glaziovii*, the *Ficus gameleira*, and varieties of the *Castilloa*, the *Hevea*, and the *Hancornia*. "The production of Pará rubber," says the Scientific American, December 5, 1896, "increased from 8,243,000 pounds in 1865, to 15,144,000 in 1875, 29,310,000 in 1885, and 46,363,000 pounds in 1895; the great advance in the decade between 1885 and 1895 being the direct result of the increased demand produced by the tire-makers. Last year 37,456,000 pounds were delivered to manufacturers in the United States, against 31,062,000 pounds in 1894 and 35,583,000 pounds in 1893. The highest price paid in this country last year for fine Pará rubber was eighty-one cents and a half in November." The United States has been from the first the largest consumer, and an American syndicate, it is said, is now seeking capital to develop ten million acres in the Orinoco Valley, chiefly with a view to profits from the great virgin rubber forests known to exist there.

Enormous supplies are stored up in Africa and her adjacent islands, where a variety of *Ficus* and great climbing shrubs, the *Landolphia* and *Vahea*, produce it. Stanley alludes to great numbers of these climbers entwining the trees, so as to make passage exceedingly troublesome. Attempts to force the price to unreasonable limits are therefore not likely to meet with permanent success, and we may banish fears of approaching exhaustion. The gum fully thrives, seemingly, nowhere but in the tropics. "It is the one jungle product which society finds indispensable," said The Spectator recently, and, further: "Everybody knows that in the last five years the use of pneumatic tires for cycles and solid rubber tires for horse-vehicles has enormously increased our consumption of this article; but, quite apart from that more obvious fact, India rubber is daily being introduced more and more into all sorts of machinery. Highly competent judges say that if the output could be doubled within a year, so many applications would instantly arise that the price would not fall appreciably." The negroes have no regard for the climbers, and cut them down in order to extract the utmost possible amount of sap.

As a result of this practice collectors have to go farther and farther inland for a supply, so that it often does not pay to transport it to the coast. There is a vast need of better management in collecting and curing the gum, as the African product is of lower grade and brings less than many other sorts in the London market. It seems a certain source of wealth, and is easy of cultivation, so proper steps are almost sure to be taken for its encouragement by the nations engaged in civilizing the continent. Traffic in India rubber is one great incentive for the building of the Congo Railroad.

Asia was the second country to furnish Europe with India rubber. The supply has of late years decreased in importance in consequence of the destruction of the trees. American varieties have been introduced with some success by the Indian Government. The principal native trees are the *Urceola elastica*, the *Ficus elastica* (the well-known window plant) and a species of fig, the *Ficus religiosa*, which is one of the most beautiful trees in the world. Its branches bend down, take root, and form new trunks. The great fig of Narbuddah has three hundred and fifty large and three thousand medium-sized stems, thus constituting in itself a veritable forest. The principal rubbers from India are the Assam and Rangoon. India rubber is also obtained in Oceania, notably in Sumatra, Java, and Borneo, but very little comes from Australia. It was formerly thought that the rubber tree only grew in moist ground, under tropical suns, but explorers have found them in hard soils on high plateaus. A beginning is being made with cultivation of the trees. The Indian Government has a nursery of Pará trees in Assam extending over two hundred square miles, and has shown that they may be productively raised from foreign seed with little care. The cultivation is also attracting attention in Central America and Mexico. According to estimates, it is very profitable. The long waiting of fifteen to twenty years, however, till the tree attains its full vigor, is apt to make individual capital cautious.

France was the cradle of the rubber industry, and French researches permitted the anticipation of many applications of the substance afterward carried out by the English and Americans. La Condamine, who was with the expedition sent to the equator by the French Academy, found the novel article at Quito, where it was known as caoutchouc (from *cahuchu* of the Maïnas Indians), and sent the first accurate knowledge of it to Europe in 1736. The natives called it *hhévé* (hence *hevea*). The Omaguas made water bottles of it, provided with a cannula, which were presented to guests before the repast. They were primitive syringes, and gave the name to the tree in some localities. Hérissant and Macquer, in France, soon attracted attention to the gum by their

investigations. Some confusion prevailing in regard to the expression "India rubber," what follows may justify the English name of the substance: In 1765 Aublet announced his discovery of the tree in French Guiana. In 1772 Magellan, descendant of the great navigator (*Le Caoutchouc et la Gutta-Percha*, E. Chapel), proposed caoutchouc, or "*résine élastique de Cayenne*," as a substitute for bread crumb in erasing pencil marks. It was known in France as *peau de nègre*. In England, where the discovery was attributed to the celebrated Priestley, who only propagated a foreign idea, designers soon came to call the article "Indian rubber." It was not known as a product of Asia until 1798. Hence the thought of the time probably connected it with its South American habitat and thus with its Indian gatherers. The appearance of the little cube in the shops about 1775 was the beginning of the great part now played by India rubber in the arts, sciences, and industry. In 1780 Berniard, a Frenchman, experimented in a line with Hérissant and Macquer, and found oil of turpentine to be the best solvent. He also succeeded in imparting various colors to the gum.

By 1791 syringes, sounds, bougies (1779), and elastic bands had been made of caoutchouc. The manufacture of impermeable tissues had been tried in France in 1791 by Besson. The idea was borrowed from the Indians, from whom the early Spaniards had learned to gum their hempen cloaks, which when thus treated were impervious to rain, but degenerated in the sun. Hancock and Mackintosh, in England, were the first to make waterproof garments, later than 1818, the rubber cloth being used as lining (E. Chapel). Hancock devised important processes for treating rubber, and in 1838 invented ink erasers; but it remained for Mackintosh alone, by employing benzene as a solvent, to produce, in 1823, the first successful garments, which at once came into great favor, in spite of their disagreeable odor. At present, three tissues are made: "simple tissues" (having one rubber face), "double-faced tissues" (rubber on both sides), and "double tissues" (two stuffs with one rubber coating between). "Mackintosh" is "double tissue," and the method of manufacturing it is substantially the same as at first, only machinery is used. In the calender machine the fabric is spread with rubber solution, is drawn by a roller under a scraper to remove excess, and passes upon a steam table, where the solvent evaporates, leaving a thin pellicle of rubber on the stuff, which thoroughly dries in passing around a drum and is wound upon a mandrel. It may then be taken to the front of the machine and the process repeated. Ten coats are sometimes applied. The product must afterward be vulcanized, to render it less sensitive to heat and cold.

Many do not understand how much we owe to vulcanization

and to the American, Charles Goodyear, its real discoverer, who indefatigably pursued it many years through prosperity and want, encouragement and discouragement, now with friends around him, and, again, lying in a debtor's prison. La Condamine found India-rubber boots among the South American Indians in 1736. Up to 1820 the *seringueiros* had sent rubber to European markets in the form of "pears," or bottles, and rude shoes. They were termed "shoemakers" in consequence, but the appellation has fallen into disuse. The gum did not begin to be known in the United States until 1820. Three years later, five hundred pairs of Brazilian shoes of direct importation had been sold in Boston. Between 1845 and 1850, flat balls, "biscuits," as at present, began to be sent. Rubber threads, making elastic suspenders, garters, etc., possible, were first made, in 1830, in France, and speedily became an important manufacture. About this time the child's ball was doing more to popularize the novelty than anything else. Soon after, the manufacture of rubber became so important in New England that from 1834 to 1836 new factories rose on all sides. But the popularity of the new substance declined when it was found that rubber lost its elasticity at low temperatures and was deteriorated and stuck together at high ones. Then, when many factories in America had closed, and English and French manufacturers were menaced with ruin, Goodyear succeeded in producing rubber unalterable by cold or ordinary heat or solvents, and some of his dark-yellow shoes and bands of perfect elasticity met with a glad reception in Europe in 1841. In 1839, Nathaniel Hayward, an American, had patented a process for powdering the sheets of rubber with sulphur. The discovery was simultaneously made in Germany by Dr. Luedersdorf. But neither thought of applying heat. Goodyear, who had been experimenting with India rubber for four years, bought Hayward's patent, and after long investigation accidentally found, in 1839, that heat caused the sulphur and rubber to combine so as to change the nature of the latter. He afterward conceived the idea of plunging the rubber into a bath of sulphur. The process is called "vulcanization." Goodyear's experiments also laid the basis of hard-rubber manufacture. Hancock, in England, scraped the new article, and was led to make and patent the same discovery in 1843, while Goodyear, through negligence, did not obtain a patent until 1844. Alexander Parkes patented a process in 1846, when molding was invented by Hancock, in which rubber is vulcanized almost instantly by dipping in a mixture of chloride of sulphur and sulphide of carbon; so we now have three processes: "The Goodyear" by steam (improperly), "the Hancock" in the sulphur bath, and "the Parkes" or dipping. They are all reliable and inexpensive. No important discoveries to change the

method of treatment have been made since Goodyear, who died in 1860.

The problem of regenerating vulcanized waste (old shoes, etc.) has not yet been satisfactorily solved, no means having been found to remove the sulphur completely, and to restore to the gum its original properties; yet there is an increasing tendency to use partly reclaimed rubber and foreign mixtures. From 1881 to 1883 the waste followed the rise in the price of the gum, and this led to the use of imitations made from linseed oil (first announced about 1846), from arachis, and from colza oil, and they still continue to be considerably employed in the fabrication of cheap articles.

Pure India rubber is whitish. It is rarely used, the vulcanized being preferred. Crude rubber is often mixed with pieces of bark, stone, clay, etc. The lumps are softened in hot water, cut into slices, generally by hand, and passed through washing rollers to remove foreign substances. When dried, they are ready for mixing with sulphur, etc., or for the "masticating machine," which kneads the stuff into a solid mass. The machine gets very hot and has to be cooled with water. The gum is then heated, molded, and cut into sheets by a rapidly moving knife. Balls, etc., which are made of these sheets, have to be cemented. It was not until about 1850 that manufacturers of "balloons" (hollow articles) began to make the endless variety of playthings with which the child of the present is familiar. India rubber grinding stones are made of the waste by an admixture of glass, pumice stone, or emery. Kamptulicon, of English origin, invented about 1843, is a mixture of rubber and pulverized cork applied to coarse cloth and covered with several layers of linseed oil. It is now largely superseded by linoleum (Walton's patent, 1860). Imitation leather and ivory (the latter not with complete success), hevenoide (for billiard balls, piano keys, etc.), baleinite, plastite (for gun rammers, canes, whip handles, etc.), and similar products are also made; even sponges. Stamps were made early in the history of India rubber, and by an American, James Peck, in 1862. They were ruined by the ink, and had to be abandoned until inks with an aniline base came, when they were able to supplant almost all their rivals. Hard-rubber dental plates are said to have been the invention of Dr. Evans, an American dentist in Paris, in 1854. He made several pieces for Goodyear's use in 1855. The latter showed them to Dr. Putnam in this country, who, with the assistance of a chemist and Goodyear, finally succeeded in making an article which has now obtained a high degree of perfection. Street-paving has been tried with success in London and Hanover. It deadens the rolling of vehicles, but the cost bids fair to prevent its general introduction. India-rubber horseshoes, an

American patent, are announced, for special use on asphalt pavements.

It is impossible to mention all the uses to which India rubber is applied, and reference can only be made, in concluding, to two more, very important ones. It is at present finding increasing favor in tires for vehicles, the solid kind being most frequent, though occasionally pneumatic-tired equipages are seen. Hancock claims to have made the solid kind for her Majesty in 1846. The recent tire of American invention with wires running through it is thought, in this country, to be the best, as double the quantity of rubber of better quality is used, which secures greater elasticity, and vastly cheaper, from better rim-construction and because worn spots may be cut out and renewed. The bicycle industry, it is estimated, is turning out, in 1896, in the United States alone, six hundred thousand bicycles and one million and a half pairs of pneumatic tires, which will require about one thousand tons of rubber. The output in England is about the same, that country and the United States producing seventy-five per cent of the wheels manufactured. A writer on this subject (Hawthorne Hill) recently said that probably not more than four per cent of the output of rubber is used in the bicycle trade.

The discovery of gutta-percha, which seems to unite all the advantages of India rubber, excepting elasticity, without its disadvantages, has sometimes been attributed to the traveler Tradescant, who brought it to England, where it was known as mazer-wood. It was neglected and soon forgotten. To an Englishman, Dr. Montgomery, is due the merit of having brought the importance of the new article to the attention of the world of science and industry. Hearing of it at Singapore, in 1822, he procured specimens from the natives, who collected it in the neighboring forests, and formed it chiefly into axe handles by malaxation in boiling water. He found it differed materially from elastic gum. Having proved that it retained the shape on cooling, imparted to it in boiling water, while recovering its hardness and primitive tenacity, Dr. Montgomery thought such a substance could serve better than rubber for certain instruments of surgery, and communicated his views to the Medical Board of Calcutta in 1843, which warmly indorsed the idea. He also sent specimens and a study of the product to the London Society of Arts, and received from it a gold medal in recognition of his important discovery. According to Dr. Gützlaff, the celebrated missionary, gutta-percha was known in China long before it appeared in Europe, though certainly not gathered there.

Gutta-percha, like India rubber, is obtained from the juices of certain trees and climbers. The best is produced by a tree, the

Isonandra gutta, of the order *Sapotaceæ*, which formerly abounded at Singapore and in all Malaysia, but which now tends to disappear under the ravages committed by gatherers. *Gutta*, in Malay, signifies gum or lime; *percha* signifies scrap. Incisions are made in the bark, as on rubber trees, and the liquor flows of perfect whiteness, darkening at contact of air. Coagulation takes place spontaneously in a short time. Like rubber, the liquid forms a film on top. This cream is removed, kneaded into a large lump and plumped into boiling water. Under the action of a high temperature it softens and forms the cake usually found in commerce. Other trees in Malaysia and Farther India, in Cambodia and Cochin China, produce good gutta. In Hindustan different grades are mixed by the natives. Chinese merchants, in their depots, mix and manipulate to give a good superficial appearance to the product, as the price is constantly advancing. As the gatherers also do not scruple to add vegetable *débris*, earth, or sand, it has become difficult to secure a pure article. An inferior quality is obtained from trees and climbers in Africa and Madagascar, and, with the development of those countries, more may be expected. For the present, the same ravaging system of gathering seems bound to prevail in these countries as that which the now indispensable gutta-percha and India-rubber growths are suffering in other countries. The valuable discovery of enormous supplies of gutta trees in the vast forests of Guiana was made about 1860. As might be expected, the rich flora of Brazil furnishes many varieties of the tree; one of which, the *Mimusops elata*, exudes a white liquid of an agreeable flavor, which is often used with tea or coffee. Other countries to be mentioned are Venezuela, Costa Rica, and Australia. (For the botany of India rubber and gutta-percha, the reader is referred to E. Chapel's comprehensive work, *Le Caoutchouc et la Gutta-Percha.*) Some growths produce *caoutchouc gutteux*, a substance of inferior quality, having the character of gutta-percha and India rubber.

The largest quantities of gutta-percha come from the Sunda Islands, Cochin China, Cambodia, and Hindustan. At first it was exported exclusively from Singapore, but now some shipments are made direct from the above-mentioned regions, from the island of Celebes and the Philippines; some going to the United States and the ports of Amsterdam and Rotterdam, but the greatest portion to England.

The different varieties in European markets are designated after their place of origin, the best being the Macassar, Java, Sumatra, Borneo, etc. The gutta-percha of the Orient is of various colors. The best grades are white or grayish, slightly rose-tinted, and generally contain very little foreign substance; in-

ferior grades are dark and mixed with impurities. The former are tenacious, the latter often very friable. Macassar and Sarawak, the finest grades of gutta, are light-brown verging on yellow, while Balata is rose-brown.

On being refined and drawn thin, gutta-percha is translucent; drawn very thin, it is transparent; but placed on a white surface, it is rose or gray. At ordinary temperatures it is supple, flexible, and very tenacious and extensible, so that it may be drawn to three times its length, when it retains almost all of the extension. If a dent be made with the finger nail, a trace will remain. It softens above 50° C. and becomes adhesive above 100° C. Two pieces may be permanently joined by applying a hot iron to the surfaces and using light pressure. It is a bad conductor of heat and electricity, but may be electrified by friction; so it is sometimes employed for the disks of electric machines. Exposed to the air, it undergoes, at length, a great change, losing its fibrous structure and becoming granular and friable; more quickly in hot countries. This is a result of the action of oxygen under the influence of light. It is insoluble in water, softens in boiling water and steam; resists alkalies, hydrofluoric acid (being used for a receptacle for this acid), and ordinary dilute acids, but, when strong, they attack it.

The property of gutta-percha of greatest value to mankind is its dielectric or nonconducting property. This is not lessened by atmospheric conditions, nor is it destroyed by plunging under water or burying in the ground or subjection to other deteriorating influences. Hence its fitness for cables, telephone wires, etc. Its power of insulation decreases as the temperature increases. Sea water is a medium in which gutta-percha undergoes no alteration, and the enormous pressure at great depths exerts a favorable action on it by closing up accidental splits. Wrappings are put upon electric cables to protect the insulation from abrasion and the attacks of marine animals, as well as to strengthen the cable. Gutta insulation is preferred for telegraphy, telephony, bell service, etc.; rubber insulation for lighting and power, as intense currents are liable to lead to accidents by fusion of gutta insulation. What the world owes to gutta-percha may be most easily illustrated by more than one hundred and thirty-nine thousand miles of ocean cables, not to speak of the myriads of wires on land, under it, and in buildings for every conceivable purpose.

As soon as this valuable substance became known, industrial enterprise at once sought to make use of it. From the year 1844 the new product received numerous applications and gave rise to many patents. It was used for making stoppers, glues, and wires; then shoes, surgical instruments, and clothing. The most fortunate application was as coating for telegraph cables (patents to

W. H. Barlow and Theodore Forster, April 27, 1848, and to E. W. Siemens, April 23, 1850). Efforts had been made to solve the problem of submarine telegraphy for some years. The Count de Moncel, in his *Traité de Télégraphie Électrique*, gives to Mr. Wheatstone, London, the palm as its inventor, but all do not agree in this. The first mention (The Atlantic Telegraph, W. H. Russell) we are able to find of a current being transmitted a distance under water refers to Sir W. O'Shaughnessy, Superintendent of Electric Telegraphs in India, who hauled an insulated wire across the Hoogly, at Calcutta, and produced electric phenomena on the other side of the river, in 1839. Wheatstone, who is said to have been thinking of binding England and the Continent in electric connection as early as 1837, laid a plan before the House of Commons in 1840 for a cable between Dover and Calais. He seems to have had no definite idea of the kind of insulator to be employed, and, as the insulating quality of gutta-percha was not yet known, his project was not carried out. Morse, in 1842, had succeeded in telegraphing with a copper cable in New York harbor from Castle Garden to Governor's Island, and said, in a letter to the Secretary of the Treasury in 1843, that electric communication "may with certainty be established across the Atlantic Ocean." Three years later Ezra Cornell had successfully employed a cable insulated with rubber in the Hudson at Fort Lee; and in 1846 Colonel Colt, the patentee of the revolver, and Mr. Robinson, of New York, laid a wire across the river from New York to Brooklyn and from Long Island to Coney Island. So this great fact of instantaneous exchange of intelligence with nations beyond seas was in a promising embryonic stage. Yet a satisfactory insulation still was wanting. Then, at the very time when science was earnestly seeking to find a suitable insulating material, Montgomery was studying the properties and supply of gutta-percha. The late distinguished German inventor, E. W. Siemens, recognized the superior insulating power of this substance in 1846, and constructed the first subterranean line in Germany in 1847. Thence to the submarine cable was but a step.

It is now interesting to Americans to note that S. T. Armstrong, of New York (The Story of the Telegraph, by Briggs and Maverick; The Telegraph Manual, by Schaffner), who had been invited to England in 1847 to inspect the products of the new industry, established this industry the same year in Brooklyn (as the president of a company), and made highly favorable experiments across the Hudson in the autumn in 1848. He was so sanguine of the success of gutta-percha insulation that he offered in The Journal of Commerce, the same year, to lay a line across the Atlantic for $3,500,000. (We have been careful to allude to this, as there is usually no reference to Armstrong's experiments in

works upon the subject.) Nor was it until January 10, 1849, some months later, that Walker, one of the first *savants* that busied themselves with electricity, and who first experimented with the railway block-system, successfully telegraphed in the harbor of Folkestone on what is generally considered the first submarine cable. It was a gutta-covered cable extending from a boat two miles to the shore. The favorable results at Folkestone encouraged John W. Brett, who is known in England as the father of submarine telegraphy, to construct the first long line from Dover to Calais, with the encouragement of the French Government, in 1850, when the successful application of gutta-percha to real submarine telegraphy was demonstrated and Wheatstone's hopes were completely realized. Brett labored with great energy for the success of long-distance submarine communication, and his faith and advice, as well as capital, were of the very greatest value to Field and his fellow-promoters of the first Atlantic cables. In 1851 the fire-hose at the exposition in London was of this substance, and on the last voyage in search of Franklin a light and portable gutta-percha boat did good service, showing that the material was suitable for the sheathing of boats. Advantageous use was also made of it in making molds for reproducing delicate impressions in the galvanoplastic process. But, except in telegraphy and galvanoplasty, its employment soon diminished. Shoes of gutta-percha softened before the fire and stuck; clothing made of it in turn fell into ill favor. Vulcanizing and mixing with rubber were thought of, but still satisfactory products were not obtained. They were hard and were soon abandoned.

The failure of gutta-percha for some purposes is owing to its greater suppleness at a slightly elevated temperature. It may be vulcanized by adding sulphur and heating to 135° to 150° C., but this process, owing to inconvenient results obtained, is now very rarely employed. Its resistance to acids led to its being put to use for vessels and tubes in factories of chemical products and laboratories, while medical science, as seemed promised at its coming, has found in it a valuable auxiliary.

The gutta-percha of commerce contains impurities—wood, earth, sand, etc.—which must be eliminated. It may be dissolved in sulphide of carbon or benzene. Then decant and allow to evaporate. A cheaper and preferred method is by mechanical means. The cakes are cut into chips, which are plunged into a hot-water vat and stirred by an agitator; the heavy substances go to the bottom, the gutta and wood remaining on top. A series of rasps removes the wood, and the gutta is taken and dried. The process is often accomplished by still other machinery for removing the foreign substances, care being taken to squeeze out all the air bubbles. The gutta is now pure, but may be mixed with

other substances to harden it or diminish the price. *Caoutchouc gutteux* is sometimes added to make it more supple, and a certain degree of elasticity may be imparted to it by adding India rubber of good quality. With the perfect machinery now employed it is made into sheets of almost any desired thickness. Many articles are molded and the seams are finished with a hot iron. Cords and tubes are made by a machine employed for similar articles in the manufacture of India rubber, and which is on the principle of one used in making macaroni. Belting is made for use in moist air or where acid vapors are given off. Such belts have less resistance than those made of rubber or leather, and are only used for small powers. According to Meyer's Lexikon, there is a transparent gutta-percha varnish which can be used for covering documents. It does not change the paper; the document is perfectly protected against water, acids, and alkalies; and the writing can not be erased. Gutta-percha is also used in dentistry.

At the International Congress of Electricity at Paris, in 1881, the alarm was sounded in regard to the decreasing supply of this substance, and England, France, and Holland caused investigations to be made with a view to gutta-percha planting, but they do not seem to have led, as yet, to any specially practical results. Land of volcanic origin has been observed to be favorable, and heat and light and constant humidity the conditions essential for the growth of the tree. There are vast regions in Cochin China and Cambodia where, it is said, the *Isonandra* could be grown at slight expense; while all Malaysia, and probably other regions where it grows native, would be found to lend themselves to the same purpose. As the tree requires thirty years to reach maturity, little can be expected from private enterprise, and national aid should be extended. Meanwhile, the increasing demands of submarine telegraphy, etc., and the ruthlessness of gatherers are making it scarcer, and manufacturers must speculate with very variable prices.

In his presidential address before the Royal Geographical Society Sir Clements R. Markham cites the execution of the Periyar Canal, in the Madras Presidency, India, as a most striking example of the power of man to alter permanently the physical geography of a region. The Periyar flows northward between the ridges of the western Ghauts Mountains, breaks through them, and reaches the coast on the western side, in a region abundantly supplied with water, while Madura, on the east side, is an arid plain, constantly parched. The canal has been completed, with a tunnel through the mountains, and the river has been turned to the western side, making the effectual irrigation of Madura practicable. As opposed to the too many instances in which man has injured the countries some of whose geographical conditions he has changed, we have one here in which by careful calculations and high engineering skill he has conferred great and lasting benefit upon a region.

SKETCH OF JOHN GUNDLACH.

By JUAN VILARÓ, M. D., A. M., Ph. D.,
PROFESSOR OF NATURAL HISTORY, HAVANA UNIVERSITY.

THE words by which Sir William Jardine characterized Alexander Wilson may be equally well applied, with a slight change, to Gundlach, the Cuban naturalist. He "was the first who truly studied the birds of *Cuba* in their natural abodes from real observation; and his work will always remain an ever-to-be-admired testimony of enthusiasm and perseverance." Gundlach studied with equal completeness all the land and river fauna of Cuba and that of the sea, except the fishes, on which Poey was engaged.

John Christopher Gundlach was born July 17, 1810, at the University of Marburg, Hesse Cassel, where his father, Dr. John Gundlach, was Professor of Mathematics and Natural Philosophy. When the father died he left his five children a good name and a noble example; and the mother received a pension.

These resources, however, were not sufficient for so numerous a family. Great sacrifices were necessary if so many children were to be fittingly educated. The young students were compelled to devote their leisure moments to work, instead of the exercises of pleasure and recreation which were the privilege of their fellows. Henry became a doctor of medicine; Conrad, a Protestant minister; William, a guardian of the forests; and John accustomed himself, to use his own words, to "accept destiny in whatever shape it might present itself," and to do much while he spent little. He was in his ninth year when his elder brother returned from Cassel with a ready and practical knowledge of taxidermy. He used to watch the brother's work, closely and quietly following all the processes of his preparations. The boy was an industrious collector of insects all the while; and in the study and classification of his collections enjoyed the counsel and assistance of naturalists, who were glad to give him their encouragement. Those fruitful collecting excursions were the pastime of his youth. About this time the young man suffered a serious disaster from the accidental discharge of a shotgun, by which his nose was shattered, and he was permanently deprived of the sense of smell. The misfortune, however, had one comforting compensation, in that the student was thereby enabled to deal with subjects in extreme stages of decomposition as easily as if they had been entirely fresh. He gained an extensive reputation as a taxidermist, a practical demonstration of which was the fact that a captain residing in Marburg intrusted him with the preparation and mounting of his valuable collection of birds.

Gundlach's mother sought vainly to guide his steps through the mazes of theological studies; and although he at one time, in deference to her wishes, began a course, he was not destined to complete it. Dr. Maurice Herold, Professor of Zoölogy, offered him employment in the university as conservator and preparator —a position in which he had advantageous opportunities for prosecuting the embryological work in insects which he had undertaken. Enjoying as the son of a professor the privilege of gratuitous instruction, he was enabled, while assisting Dr. Herold and serving as his substitute, to take three successive courses in zoölogy. He obtained, in 1837, the degree of Doctor of Philosophy and Master of the Liberal Arts; while he had also been elected to the Society of Natural History of Cassel.

Gundlach was invited by Dr. Julius Hill, a Dutch physician, to visit Surinam, where a company had been organized for making collections; and by the Cuban, Carlos Booth, who had completed his studies at London and Cassel, to go with him to Cuba. He accepted the latter invitation, and, sailing from Hamburg early in November, 1838, landed at Havana, January 5, 1839.

He at once made a favorable impression in Cuba. He might have speculated in the results of his researches, but refused to do so, giving as the reason, when asked by the writer of this sketch, "Booth having incorporated me into his family, I had no expenses and could send these objects gratuitously to Cassel."

The venerable Simón de Cárdenas wrote of him at the time that "of a modesty equaled by none, he ever ignores the price of his works. Tolerant with all, he never criticises. He only knows how to give good advice. His amiable character is invariably the same. . . . That science fills his soul and heart is a fact that needs no demonstration. The impetuosity of violent passions is something entirely unknown to his nature, and for him there is nothing in the world but study and friendship."

Juan Clemente Zenea, in his *Revista Habanera* (1861), spoke of Gundlach's zeal and devotion to science, his modesty and unselfishness, in terms of the highest eulogy, saying, among other things: "For the last twenty years our richest planters have been disputing among themselves for the right and pleasure of giving him hospitality and attending to his needs, which are few, and he only cares for the study of science. . . . He is a naturalist as others are soldiers. . . . He is entirely unconscious of his distinction. He unassumingly communicates his vast knowledge to whoever may feel inclined to hear him, like a prophet inspired by a superior will."

He established himself with Booth at Cardenas, in 1841. During one of his excursions he shot a hummingbird, which he found to be of a new species and designated it after Mrs. Booth.

Up to that moment he had never collected for himself. He now decided, on the suggestion imparted to him by the study of that rare specimen, to form a Cuban collection. Removing, in 1846, to the "Refugio" farm, one mile from Cardenas, he deposited there his collections, which had acquired great value, and freely exhibited them to the numerous visitors who were attracted to the spot. Six weeks of the year 1850 were spent at San Juan de los Perros, on the coast of Cardenas, in collecting vertebrates, articulates, and mollusks, while the fishes were left to Poey.

At this period Gundlach formed a number of valuable scientific acquaintances and friendships. Señor Blas du Bouchet, assessor of Cardenas, made several visits to the Refugio, and a close association was formed between the two. Going to reside in Havana, thirteen years after his arrival in Cuba, Gundlach for the first time met Felipe Poey, whom Dr. Manuel Presas styles the true inaugurator of the new era of Cuban science, and whom he had before known only by correspondence. The greeting between the two was a warm one—"*Animæ pars*" (Part of my soul), exclaimed Gundlach; "*Dimidia meæ*" (Half of mine), responded Poey—and was the beginning of an intimacy which was cordial and lasting. In Havana he found, too, Juan Lembeye, the ornithologist, author of a little treatise on the birds of the island of Cuba,* whom he had known since 1846; Ramon Forns, Principal of the "Santa Teresa" School, another ornithologist; Antonio Fabre, Francisco A. Sanvalle, and Dr. Manuel Gandul; and a very pleasant circle of naturalists was formed for profitable intercourse. Very fruitful expeditions were made in 1855 to the mountain called the Pan of Guajaibón; and the encouragement of this success was an important factor in the development of a plan for exploring the Island of Pines. Dr. Nicolás Gutierez, Patricio Paz, and Poey found the means to carry out the idea, it being agreed that they should pay all the expenses and share with Gundlach the scientific harvest. The riches thus acquired stimulated desire, and the project of a new expedition to the east of Cuba was formed, with a view to the collection of mollusks, and particularly of the *Helix imperator*.

Gundlach started on his journey alone in June, 1856, and prosecuted it with an earnestness that nothing could dampen, and a determination that overcame every obstacle of bad roads, dense thickets and foliage, mountain ranges, the burning heat of the day and the cold of the night, tropical showers, high waters, and mud up to the neck, with all the hardships they could inflict

* A continuation of, or rather a supplement to, the Physical, Political, and Natural History of the Island of Cuba, published by Ramon de la Sagra, in which the part allotted to ornithology is edited by Alcides d'Orbigny.

upon him. He went overland from Havana to Cienéga de Zapata (Zapata Swamp), thence to Caimanera and Cienfuegos. In September he passed through Trinidad, San Juan de Letran, Güinia de Soto, Araca with its great marsh, and other places, all of which were closely and attentively examined.

On the 22d of February of the following year he started from Casilda toward Manzanillo, thence to Bayamo, where he was entertained with true Cuban hospitality. Drawn by an irresistible desire to acquire more specimens of a very interesting mammal known locally as *tejón*, called *almiqui* by Poey and his successors, and scientifically named *Solenodon cubanus* (Peters), he traversed the Sierra Maestra. Another mammal, the *Jutia andaráz* (*Capromys melanurus*, Poey), of which he had obtained specimens from Dr. Yero, also attracted him thither. Besides having specimens of these species, he desired to trace them to their homes and follow them to their burrows, but his success was prevented by natural obstacles which he could not overcome. With the Yero brothers he went to Guisa, where he found in one of the caverns the interesting bat *Monophyllus Redmanni*, and many specimens of mollusks. Reaching Santiago de Cuba in December, 1857, he closely investigated its vicinity. He revisited Cabo de Cruz in April, 1858, in search of the tropical bird *Phaëthon flavirostrus*—called in Cuba *rabijunco*, from the two median rectrices that gracefully prolong its tail—which disappears from the place in the latter part of August or beginning of September and returns in February, and obtained very good specimens of it. In June of the same year he visited Caimanera, in the harbor of Guantánamo, for mollusks. At Zateras, in 1859, he met the botanist Charles Wright, of Connecticut, who had already collected a number of plants for Harvard University and had returned for new finds. The two explored in company, mutually aiding each other; and Wright acquired snails and insects and bird skins for the Smithsonian Institution, in return for which Gundlach had seeds and specimens of plants to send to Havana. He returned to Santiago de Cuba; visited Baracoa in May, where he went to the "Marianna" estate to see the famous branching palm; ascended the mountain called *Yunque de Baracoa* (Baracoa Anvil), where he discovered a number of insects and new species of mollusks; and went on by way of Gibara to Nuevitas, whence he passed to Puerto Principe, and finally arrived in Havana in August, 1859, three years and three months after his departure on the expedition.

Established again in the Cuban capital, Gundlach occupied himself with the systematic compilation of his collections. He described and published three new species of birds; sent the reptiles to Dr. Peters, of Berlin, for classification, and the land

and river mollusks—which he had already himself partly named—to Dr. Pfeiffer, of Hesse Cassel; while he reserved the insects for German and North American specialists.

After other journeys to Vuelta Abajo, Gundlach decided to gather all his collections under one roof. He furnished for that purpose a room on the upper floor of the infirmary of the sugar estate "Fermina" (Bemba), where the valuable Cuban Museum of Natural History was installed during the holy week of 1864.* There all the zoölogical species, especially birds, were represented by specimens of both sexes, young and old, their eggs and nests, with cases of albinism and melanism and anomalous features, especially of the bill. In 1866 Gundlach prepared—arranging and packing—the specimens for the Cuban exhibit in the Paris Exposition of 1867. The exhibit included a collection of land and river mollusks, a Cuban herbarium, and a collection, no less valuable, of woods and textile plants; geological and mineralogical collections; sections of fossils; and other specimens of the products of the island. In it the collection of the Academy of Sciences of Havana was added to Gundlach's own.

The breaking out of the Cuban insurrection in 1868 made the continued exploration of the island impracticable, and Gundlach turned his eyes to Porto Rico. He visited that island in 1873, and traversed, investigated, and studied to great advantage the surroundings of Mayagüez, Aguadilla, Quebradillas, Arecibo, Guanica, Utuado, and Lares. The six months work done here did not, however, satisfy him, and he returned in 1875, when he also explored Jayuya, Vegabaja, and Bayamon. Receiving news of the burning by the rebels of some estates near the "Fermina" sugar plantation, he at once abandoned everything to go to the rescue of the museum, his only treasure.

In 1884 he started anew in the direction of Santiago de Cuba and Guantanamo in search of certain birds and butterflies. Although he did not find the immediate object of his quest, his labor was rewarded by the acquisition of other specimens which speedily found their way to the university, the Institute of Havana, and other scientific centers. He returned in 1885, having with him, among other trophies of his enterprise, several good specimens of the ivory-billed woodpecker, a species which, thanks to the careless destructiveness of hunters, is becoming quite rare, and of the *Papilio Gundlachianus*. "Every trip to the mouth of the Aguadores River," he wrote to the author of this

* The Gundlach Cuban Museum is certainly worthy of special attention. A more detailed account of the treasures it contains is in preparation. The collections are now deposited in a private hall of the Institute de Segunda Enseñanza of Havana. In April, 1890, it held 4,135 species.

sketch, "had to be begun at half past five in the morning. It was there that the *Papilio Gundlachianus* flew. I had to walk two leagues, stand three hours, and then walk back two leagues more. The heat was unbearable." This *Papilio* is highly valued by students of Lepidoptera, and the specimens command a high price. It is not so large as the *Papilio antimachus* of Sierra Leone, but it enjoys the distinction of being the prettiest butterfly in America. A goodly number of swifts and large swallows were also in the collection. Gundlach made other journeys to the eastern province in 1885 and 1887, always collecting, always active and untiring, as if his seventy-six years, in spite of the arduous nature of his enterprises, had dealt lightly with him.

His unrivaled Cuban Museum established in the Havana Institute, still claimed and received his attention to the last moment of his working life. A hearty octogenarian, he continued to devote himself, as with his old-time energy, to improving it as far as possible. Assisted by kind friends, he went up daily to his place of work, first assiduously laboring and then recreating himself with his only treasure. Finally, in 1896, the end came. He was taken from the institute to his deathbed.

Gundlach's researches in Cuban fauna are so numerous that it would be extremely difficult to record them all in a brief summary. He first published Contributions to Cuban Ornithology, 1854–1857. Then followed, in quick succession, *Index generum Coleopterum*, 1854; *Molluscorum species Novæ*, 1858; A Synoptic Conspectus of all the Birds observed in Cuba, published in the *Journal für Ornithologie*, 1861; A Review and Catalogue of the Cuban Birds, 1865; A Review and Catalogue of the Cuban Reptiles, 1867; New Contributions to Cuban Ornithology, in the *Journal für Ornithologie*, 1871, 1872, 1874, 1875; Contribution to Cuban Ornithology, 1871, 1876; Contribution to the Ornithology of Porto Rico, 1874; Contribution to Cuban Mammalogy, 1877, 1878; Notes on the Fauna of Porto Rico, 1878; New Contributions to the Ornithology of Porto Rico, 1878; Contributions to Cuban Herpetology, 1880; Contributions to Cuban Entomology, 1881; Land and River Mollusks, 1883; Sea Mollusks, 1883; besides descriptions of new species of mammals, birds, reptiles, and insects, published in journals, organs of learned societies, etc. Gundlach was also distinguished by his skill, grace, and delicacy as a taxidermist, the wonderful patience with which he performed every branch of that work, and the gift of genius by which he was able to give a startlingly natural pose to the specimens he mounted.

The list of honors which Gundlach received from institutions and learned societies is a long one. In 1853 he was made a corresponding member of the Natural History Society of Montreal,

and in May of the same year was honored in like manner by the Natural History Society of Weterau. In 1861 the Academy of Sciences of Havana signified the high esteem in which it held him by conferring on him the title of Member of Merit. In January, 1864, he was made a corresponding member of the Entomological Society of Philadelphia; in July of the same year an honorary member of the Society of Naturalists of Berlin; and in the following year a member of the scientific department of the Matanzas Lyceum, and a member of the *Sociedad Economica de Amigos del Pais* of Havana. In 1867 he was elected a corresponding member of the Academy of Natural Sciences of Philadelphia. In 1872 the distinction was conferred upon him of election to membership in the Spanish Society of Natural History, Madrid. In 1878 the Farmers' Circle of the Island of Cuba (*Círculo de Hacendados*) made him a Member of Merit.

Besides his untiring devotion to science, which has been evident in nearly every line of this sketch, Gundlach was distinguished by unaffected modesty and plainness and a charming geniality in his companionship. Simon de Cardenas says, in the tribute from which we have already quoted: "He sympathizes with all persons he sees, and when one has had an hour with him it is a pain to part from him. He is an entertaining converser, no matter what the subject may be. He can soar in the heights of science, talk of history, literature, and philosophy, or engage in the private, intimate, and affectionate conversation of the family circle. If we were required to point out among his many virtues others equally conspicuous, we should certainly mention his honesty and disinterestedness." Juan Clemente Zena said that "in speaking of him we must needs pay him homage or not mention him at all. His face is like a transparent crystal, in which all moral perfections are reflected."

In their investigations of the electrical and magnetic properties of matter at very low temperatures, Profs. Dewar and Fleming have, according to a summary given in the London Times, completed an examination of the electrical conductivity of many pure metals, notably bismuth and mercury, and shown that their electrical resistance vanishes as the temperature approaches the absolute zero; also that at very low temperatures the electrical resistance of bismuth may be increased many hundred times by transverse magnetism. They have analyzed the effect of low temperature on magnets, and studied the magnetic qualities of iron and steel at the temperature of liquid air. They have measured the magnetic permeability of liquid oxygen and its dielectric constant, and shown that this complies with Maxwell's law. They have proved that liquid oxygen is extremely magnetizable, while its insulating and dielectric powers give it a unique position among known liquids and salts.

Correspondence.

RACE PSYCHOLOGY.

Editor Popular Science Monthly:

SIR: The article entitled A Study in Race Psychology, published in the January number of the Popular Science Monthly, has called forth several letters which show that the particular case there presented is far from being an isolated one. It is interesting to note also that the question of educational adaptation raised by the article is working in many minds, and has prompted experiments in many quarters. Before referring to these I would note that objection has been taken in one instance to discussions based upon a single case. It is in order to apply here the doctrine of Le Play, who believed that to understand society it is necessary to know its unit, the family. This, however, he declared did not necessitate the study of all families, but simply of typical families. Now, the unit of the school is the pupil, and to know the problem of the school it is necessary to study its typical unit. The study in question was a tentative experiment of this kind.

But to return to the correspondence. City and country are about equally represented in it, with the higher measure of appreciation for the study and its purport in the former. It would seem, indeed, that the problem presented is one well recognized in cities with large colored populations. The question raised in almost every case is how to adapt the day school to individuals or to a class of whom Isaiah is the type. I should answer that possibly the school is not the place in which the adaptation can be made. The school must treat the child primarily as part of a social whole. This is one of the chief benefits that it renders the community. It accustoms the young to act in concert and in obedience to a general law. On the other hand, it must approach the child also as an individual, but for obvious reasons it addresses itself to an average or normal individual. This is the underlying principle of grading which in some form or other obtains in schools of every order. Experience has shown, however, that society suffers if even a few individuals below the normal fail of development. In several foreign cities, notably Berlin and London, this has been as clearly recognized as the need of guarding against general illiteracy, and special schools for dull or abnormal children have been established at public expense. There are peculiar difficulties in the way of sifting out the colored population of a city like Washington, for example, on any such plan. Nor can we hope at present for a system of continuation schools such as is provided in Germany and Switzerland by which American youth, white or black, who leave school with the barest knowledge of the elements, might have their intellectual training prolonged, while at the same time they should be initiated into some art or trade. The only feasible plan at present is to supplement the school by auxiliary agencies, private or church. It is interesting to note that this is an expedient which is being attempted by leading colored men in the interests of the poorer and most backward of their race. Two notable efforts of this kind have been reported to me from Washington. One of these is of the nature of a veritable "settlement" in a forlorn purlieu of the city, the other is an industrial school in connection with a leading colored church. These efforts, however, are directed chiefly to girls, and they emphasize anew the extreme difficulty of adapting any agency of the kind to the needs of colored boys. The discussion of such adaptation has been promoted by the article in question. Inadequate as are these isolated experiments, they are the only resource while we wait the slow increase of pressure which, like the military and industrial stress of European countries, will yet force us to make larger provision and more varied adjustments for the education of the masses.

From the study of one hundred thousand school children of England Dr. Francis Warner is led to the conclusion that about fifteen in a thousand require particular training, and he urges that the expense of teaching this proportion in a special classroom and by special methods would be an efficient means of lessening crime, pauperism, and social failure. Discounting all hereditary differences between the black and the white races, the argument is nevertheless peculiarly applicable to the lower class of blacks on account of their well known social and family disabilities.

ANNA TOLMAN SMITH.

WASHINGTON, *January* 25, 1897.

Editor's Table.

AID FOR THE STATE EDUCATIONAL MACHINE.

MORE than once have we hinted in these columns that the only thing which can render State education successful, and enable it to accomplish the ends which a system of education ought to accomplish, is the earnest co-operation of the more intelligent portion of the public. The trouble is that the public do not in general see the matter in this light. They not unnaturally think that one of the advantages of State education is that all responsibility in connection with the matter is taken off their shoulders. When the government of a country establishes a postal service the individual citizen does not feel called upon to devote his time or his ingenuity to the task of perfecting it. Of course, if he is a reformer born, and his thoughts happen to run in that direction, be will favor the Post-Office Department from time to time with suggestions which may or may not be of value ; but in general the feeling is that such volunteer assistance is not needed. Somewhat similar—very similar indeed—is the feeling which the average citizen entertains in regard to the educational system of his State. It is something he need not interfere with : he pays his taxes, and he has a right to have his children educated ; and there the matter ends.

What the average citizen must wake up to some day is the perception that there the matter must not end. It is one thing to ask the State to arrange for the conveyance of letters or parcels ; it is quite another to intrust it with the education of youth. For the former purpose a few business arrangements, such as are within the compass of ordinary practical intelligence, fully suffice ; for the latter something more is wanted than any government, as such, has it in its power to supply. What, for example, is education without an ideal ? Can the State supply an ideal ? Individual teachers—the more conscientious ones—may have their ideals ; but do they derive these from their contact with or relations to the State ? Or is their position as State employees precisely the thing which makes it hard for them to have or maintain ideals ?

Let us, however, make it quite clear what we mean when we speak of the importance of an ideal in education, and of the utter incompleteness of education without an ideal. By an ideal we simply mean a conception of life worthy of a moral and rational being—such a conception of life as shall develop and strengthen, not weaken and wither, his or her moral and intellectual powers. The first lesson which should be taught to the child is the lesson of its actual, and yet more its potential, worth. "If," says the heathen philosopher Epictetus, "a man should be able to assent to this doctrine as he ought, that we are all sprung from God, I suppose that he would never have any ignoble or mean thoughts about himself." Now, education without an ideal is an education in which a child is never taught to think nobly of himself, and in which, by inevitable consequence, he is almost precluded from having any noble thoughts about anybody or anything. It is consequently an education without any large or worthy aim, an education in which the child is

treated simply as a piece of mechanism which has to be put in order for certain definite and servile ends. The idea which dominates State education is the idea of the struggle for life, human being pitted against human being in the scramble for material goods. We do not blame the State for this, for we do not hold it to be capable of organizing education on any higher plane. It can keep an intellectual machine shop, but it can not in any systematic manner provide for the higher needs of growing souls. It may go so far as to enunciate bald moral precepts; but it can not pronounce the master words which speak to the conscience and dominate the life.

So, as we have said, when the citizen pays his taxes and packs his children off to the public school, all is not done. If the citizen thinks the education of his children has been sufficiently provided for, there is a large chance that he will before very long be rudely awakened to a sense of his error. He will find that character is something the proper formation of which demands more care and pains than either he or the public school had thought of bestowing, and that for want of the necessary attention in this direction his children are showing a serious lack of any power of self guidance or self-control. Thousands of parents are to-day precisely in this position, with children on their hands to whose moral cultivation no proper attention has been paid either at school or at home, and who consequently show alarming signs of making shipwreck of life. The parents thought—so far as they thought about it at all—that the schools would see to the matter, and the schools threw back the responsibility on the parents: between the two stools the children have come to the ground. What parents should be made to understand once for all is that if they leave the moral interests of their children wholly in the hands of the public school, those interests will not and can not be adequately provided for. Teachers may individually do their best, but the public school as an institution can not strike the note that is necessary for complete education. It can not strike the note that Epictetus struck in the sentence above quoted; and yet, as we have said, unless the child can be taught self-reverence, he will never learn to reverence anything, and his whole life, aimless in any noble sense, will drift among the shoals of circumstance.

Deeply interested as we are in this view of the question, it was with great pleasure that we read a few weeks ago a letter in The Nation from Mrs. Elizabeth Burt Gamble, President of the Detroit Educational Union, describing what had been done in that city toward supplementing the work and influence of the schools by the concerted efforts of the mothers of the pupils. The problem, as Mrs. Gamble expresses it, is to carry more of the home into the school and more of the school into the home. The plan of action was to invite the mothers of each school district, "regardless of creed, color, nationality, or environment," to meet periodically—once a month—for the discussion of "topics best suited to aid in the proper development of the child." The co-operation of the teachers of each district was invoked, and the meetings were as a rule held in the schoolhouse after the regular school work for the day was over. Each district league conducted its proceedings in view of the needs and peculiarities of the particular neighborhood, but the central union prepared a syllabus of work for general use. In this syllabus were suggested such topics as the

following: "Proper food and clothing for children; care of the body, cleanliness, the way to prevent the formation of injurious habits; the rights of children; proper reading in the home; how to teach the children self-control and to have a proper regard for the rights of others; the duties of true citizenship; and various other subjects to be taken up by the mothers in the home."

Now, nothing could be better than this, except that we do not see why the movement should have been confined to the *mothers*. Why were the fathers not thought worthy to take a share in the good work? Mrs. Gamble states that in Detroit the movement has received a check. "At the very outset it was observed," so she tells us, "that petty jealousies and a fear of the growing influence of women would make it difficult for the work to continue." We do not see why there should be any dread of the growing influence of women so long as the latter are working judiciously toward good ends. We can imagine, however, that an exclusively feminine movement might perhaps be conducted upon lines or might become committed to positions that would excite not wholly unreasonable opposition. Zeal for reform is a noble thing, but to be successful it requires to be tempered by tact and a sense for the practicable. The matter is not one in which women solely are interested, and if the best results are to be achieved there must be a co-operation of the sexes. If the ideas of men lag behind those of women in some particulars, compensation may be found in the assistance which the former are able to lend in carrying certain limited reforms into actual practice and so preparing the way for further advance.

Mrs. Gamble raises a serious question when she asks, "Has society reached that stage where such results (those, namely, contemplated by the Educational Union) are desired?" There is, unfortunately, room to doubt whether some parents really desire the best training for their children. A parent, for example, who has no worthy ideal in life would not care to have his child indoctrinated with the idea that worldly success is not everything. Such teaching is looked upon as harmless in the pulpit; but many parents, if we are not mistaken, would be disposed to object if their children were taught anything like this at school. It is very desirable that we should know just where as a community we stand in regard to this matter. If all parents do not desire the best moral teaching for their children, all the greater need is there for an educative campaign that shall embrace parents as well as children. Certain it is that the children have a right to the best teaching—the most rational, the most humane, the most inspiring teaching—that can be given them, and no effort should be spared that could in any way tend to put the instruction given in our public schools on a right level or to supplement it by suitable home influence. The subject is one upon which too much public attention can not be concentrated, and we are glad to find from Mrs. Gamble's letter that she and her fellow-workers have no intention, despite some discouragements, to intermit their efforts. It is satisfactory to think that whatever may be done with right motives in the direction indicated must have *some* good effect. To interest even one mother or one father in what—using the words not quite in their usual sense, but in a sense more important than the usual one—may be called the higher education of their children is so far a gain; but to interest, as by proper measures might

easily be done, hundreds and thousands of parents throughout the country would be to initiate perhaps the most important reform movement that our century has witnessed.

A CRITIC CRITICISED.

A FEW months ago there appeared in France a French translation of Mr. Balfour's work on The Foundations of Belief, with an introduction by the well-known editor of the *Revue des Deux Mondes*, M. Ferdinand Brunetière. In this introduction M. Brunetière took occasion to repeat many of the arguments already used by him in his article of a year or so ago on The Bankruptcy of Science. He was greatly pleased to think that Mr. Balfour had shown that science could not lay claim to any greater certainty than theology, and he quoted with much satisfaction Mr. Benjamin Kidd's disparagements of the reasoning faculty and exaltation of the irrational or supra-rational as the source of everything good and excellent in human society and in the history of the race. It is a little wonderful that men of the general intelligence of M. Brunetière and Mr. Kidd do not recognize the futility of such intellectual exercitations as those in which they indulge; but the former of these gentlemen can at least see how his attitude strikes a common-sense observer in a very sprightly article published in *La Nouvelle Revue* of the 15th of January last.

The writer, M. Gustave Téry, begins by observing that M. Brunetière only a few years ago was one of the most severely scientific writers of the time. In physical science he was an evolutionist and in literary criticism as rigid and inflexible as Sarah Battle over her game of whist. One fine day he turned round on evolution, and shortly afterward he declared war on science. Now there is no knowing where to find him. He is here, there, and everywhere, showing different colors at different angles, and taking pride in nothing so much as an infinite flexibility of mind and conviction. His present condition seems traceable in the main to an interview he had a couple of years ago with the Pope, who showed him all the kingdoms of the world in a moment of time, and, if he did not convert him outright to Catholic orthodoxy, filled him with a holy zeal for persuading the world that science is the one thing least worthy of trust. In pursuance of this mission he has charged science with having undertaken to "explain the universe" and with having egregiously and shamefully failed to do so. But, as M. Téry says in the article before us: "What *savant* ever claimed to explain Nature in the ontological sense —that is to say, to reveal the nature of Being? All that science undertakes is to connect phenomena with one another, to relate them to their causes and formulate their laws." If, he further observes, M. Brunetière will only make this elementary distinction, he will not be so scandalized as he appears to be at the reply attributed to Laplace when some one —the pious Napoleon Bonaparte, was it not?—asked him what place God occupied in his speculations. The reply was that he did not need that hypothesis, by which he meant that a speculation as to a *first* cause had no place in a series of inquiries relating to *secondary* causes.

One of the amiable remarks of M. Brunetière apropos of reason is that while it is easy enough to see the ruins it has wrought, it is by no means so easy to see what it has constructed. This in face of the fact that day by day all the solid and enduring work in the world is done by the aid of reason and in accordance

with its rules. Do we employ lunatics as architects, as engineers, as analysts? Do we ask them to plead cases in court, to write books of science, to manage business affairs? Or, passing over lunatics, do we seek out persons of confessedly mean intelligence for these purposes? Is not all work good precisely in proportion to the amount of correct and rational thought that is embodied in it? If a bridge breaks down, or a house collapses, or a ship is lost at sea, or a railway disaster happens, or a fire sweeps through a town, or an epidemic gains headway, do we ever say that an excess of *reason* was chargeable with the calamity? Or do we, as we investigate the causes, say that here or here there was some defect of knowledge, thought, attention, vigilance, common sense—some defect of reason, in short? The question does not call for an answer, seeing that every one knows that what we need to get into human affairs is more and more reason, more and more intelligence, more and more of the spirit of science. But if, M. Téry says, we are in spite of everything to trust to the irrational or Mr. Kidd's supra-rational, who is to interpret it for us? There are many brands of the irrational, and doubtless just as many of the supra-rational. Who is to pick out the particular one that suits our circumstances and needs? Surely, reason is not to be called upon to decide in what direction we are to forsake its guidance and what precise species of unreason we are to surrender ourselves to. We should be able to look to the gentlemen who tell us how unsafe a guide reason is; but there is nothing they so pointedly decline to do as to give us any practical help whatever. The conclusion of the matter seems to be that of all the fads of the present day the weakest and silliest is that which prompts men otherwise intelligent to disparage reason and its realized outcome, science. A fitting punishment, were it possible, would be to confine such persons for a certain period to an exclusive diet of the irrational and the supra-rational. If their wits survived the ordeal, they would return to ordinary conditions with a devouter thankfulness for the gift of reason, and for all the works of reason, than they probably ever experienced in their lives before.

Scientific Literature.

SPECIAL BOOKS.

THE completion of Herbert Spencer's Synthetic Philosophy * is the most noteworthy recent event in the field of scientific literature. More than forty years have elapsed since Mr. Spencer enunciated the doctrine of evolution in the first edition of the Principles of Psychology, preceding by several years the great work of Darwin on the Origin of Species. Nearly thirty-seven years have gone by since the plan of the Synthetic Philosophy was definitely formulated, soon followed by the publication of First Principles. The accomplishment of the Herculean task then outlined is hardly less marvelous than was its projection at a time when, as Mr. Spencer ex-

* The Principles of Sociology, vol. iii. By Herbert Spencer. New York: D. Appleton & Co., 1897. Pp. 645.

plains in the preface to the present volume, his circumstances of health and fortune were most discouraging.

Though approaching the completion of his seventy-seventh year, neither Mr. Spencer's age nor his long struggle with infirmity has dimmed the vigor of his thought or the lucidity of his diction. The closing chapters of the present volume exhibit the strength of a mind unimpaired and of a conviction undaunted by the apparent drift of events in a direction contrary to that in which he sees the salvation of society. No pessimistic reflections have obliterated his early vision of an ideal man in a relatively perfect social state. "Long studies," he affirms at the conclusion of his work, ". . . have not caused me to recede from the belief expressed nearly fifty years ago that 'the ultimate man will be one whose private requirements coincide with public ones. He will be that manner of man who, in spontaneously fulfilling his own nature, incidentally performs the functions of a social unit.'"

The volume now before us includes the discussion of Ecclesiastical, Professional, and Industrial Institutions. The consideration of the two latter topics, not contemplated at the outset, has displaced the general survey of progress which was to have completed the Principles of Sociology. The finished structure is not marred; the change has enhanced the practical value of the work. In this adaptation to the requirements of added experience and maturer reflection the Synthetic Philosophy is seen to be itself a product of evolution, a vital expression of progressive thought, rather than a mechanically constructed system. That its final form is so near to the original plan is a remarkable testimony to the profound scientific prescience of the author.

The first two sections of the present volume have already received notice in these pages. The concluding section, on Industrial Institutions, is the latest product of Mr. Spencer's thought, and treats of the problems now uppermost in the minds of men. The discussion, therefore, has more than a merely theoretical value. It presents the mature judgment of the greatest thinker of our time on questions of immediate practical import. It therefore challenges the thoughtful attention of all to whom the perfection of individual character and of the societary forms best adapted to assure the progress of the race is a matter of supreme interest.

Reviewing the different stages of industrial progress, Mr. Spencer optimistically concludes that advancement has been more rapid in the century now closing than in all the past of man's career upon the earth—a conclusion seemingly justified by the facts which he skillfully marshals in its support. This progress has been characterized by an increasing specialization of functions and division of labor, thus illustrating the universal law of evolution. The chief incentives to early industrial effort grew out of the steady increase of population, the militant structure of society, and the love of ornament common to primitive peoples. Further industrial progress, however, is seen to be dependent on the decline of the military spirit. Peace alone answers the conditions requisite to continuous effort, promotes economy, and encourages better methods. Hostilities between tribes and nations prevent free interchange and competition, and so favor adulteration in materials and the survival of inefficient methods. "Thus in all ways increase of population by its actions and reactions develops a social organism which becomes more heterogeneous as it becomes larger, while

the immediate cause for the improvement in quantity and quality of productions is competition."

Mr. Spencer regards the development of a sound and convenient medium of exchange as a condition essential to that integration of industries which has everywhere accompanied the differentiation of industrial functions. The idea that each local community must be autonomous and self-supporting, peculiar to early societies and in harmony with their prevailing militancy, must give way as production increases and the means of distribution are developed. These advances are dependent on an acceptable medium of exchange. "With a good monetary system the resistance to exchange disappears; relative values of things can be measured; current prices can be recognized; and thus arises competition, with all the cheapenings, stimulations, and improvements resulting from it." A debased currency tends to limit exchanges to the community which employs it; witness the innumerable disastrous experiments with irredeemable paper money. "A developed and differentiated currency furthers production and raises the rate of distribution," thus aiding in the integration of society. Mr. Spencer's conclusions confirm the teachings of political economists, and will commend themselves to all who believe in sound and progressive financial methods.

All these processes of industrial evolution tend to raise man out of the static independence of the savage state into that higher realm of interdependence and mutual service which is his noble prerogative as a social being. By them labor is organized and regulated. Its early regulation implies either actual or potential coercion, at first effected by combined religious, governmental, and industrial control. These functions are gradually differentiated as social evolution proceeds. Emancipation from coercion is conditioned upon the higher development of character in the worker. Patriarchal regulation, communal regulation, and slavery were necessary steps in industrial progress, leading to the modern system of free labor under contract.

The place of the craft-guilds in industrial evolution is treated most suggestively. Their universal prevalence, their normal development in a militant society as substitutes for the original family groups, their important bearing on the evolution of the political franchise, are admirably expounded. It is shown, however, that the "free man" of the industrial guild was free only in a qualified sense. He was subject to many restrictions imposed both by the guild and by the government of the country. The modern trade union, while not a lineal descendant of the craft-guild, is the product of similar social conditions, and is akin to it in nature; militant in its structure and often tyrannical in its oppression of the individual worker. The fruitlessness of the attempt to benefit the worker by artificial efforts to raise the rate of wages is clearly shown. Natural law is stronger than artificial regulations. "Protected industries do not prosper." Yet Mr. Spencer recognizes the fact that trade organizations are natural to the passing stage of social evolution, and may have beneficial functions under existing conditions. Employers are more ready to raise wages when trade is flourishing than they would be without the menace of combined labor. They treat the laborer with more respect. They are led to study the convenience of the men, and look after their health and comfort. The discipline of the organization also helps to prepare the men for the higher social and industrial conditions which will probably arise.

The economic utility of the various modes of compounding capital exemplified in our modern industrial life is clearly recognized by Mr. Spencer. By the use of these methods stagnant capital has almost disappeared. Liberty of combination is asserted, subject to due responsibility of the individual shareholder. No sympathy is expressed with the prevalent indiscriminate denunciation of corporations and trusts. Possibly Mr. Spencer does not fully realize the extent to which such combinations may become a menace to the liberty of the small tradesman, the purity of legislation, and the just requirements of public service. He doubtless thinks that such evils would be self-corrective, as in the case of the various "bubble enterprises" which have been fostered under capitalistic auspices. He sees the utility of such combinations in promoting serviceable industrial enterprises, and affirms their superiority to state action in the advancement of the common weal.

The greatest interest of the reader will probably center in the closing chapters on co-operation, socialism, and the probable trend of industrial evolution in the near future. Mr. Spencer's general attitude toward these questions is well known; but he has never stated his convictions more lucidly nor with equal calmness and poise of judgment. Nor has he before presented so clearly the ripe fruit of his own mature reflection as to the ideal relation of the laborer to the product of his industry.

"Social life in its entirety is carried on by co-operation," Mr. Spencer declares. The earliest modes of conscious industrial co-operation are closely allied to similar united action for militant purposes. All modes of industrial alliance which are enforced by the state must partake strongly of the militant spirit, inhibit individual freedom, and restrain true progress along normal lines of social evolution.

The word "co-operation" is now commonly used in a restricted sense to distinguish a special form of social and industrial life. In those methods of adjusting the interests of capital and labor generally known as "profit-sharing," Mr. Spencer sees some advantages joined with serious defects. He regards them as unnecessarily complicated, difficult of comprehension by employees, and therefore not likely to prove ultimately satisfactory to them. They are based on the system of wage-labor, and this is defective in that it does not proportion the reward of services to their quality and amount. "So long as the worker remains a wage-earner the marks of *status* do not wholly disappear. For so many hours daily he makes over his faculties to a master. . . . He is temporarily in the position of a slave, and his overlooker stands in the position of a slave-driver." An ideal system will assure rewards proportionate to activities and a direct interest of the worker in the enterprise which he is developing. Socialism, whether voluntary or compulsory, violates the first of these conditions, tends to undermine family life, and is essentially militant in its social ideal. "People who, in their corporative capacity, abolish the natural relation between merits and benefits, will presently be abolished themselves."

All co-operative enterprises involving wage-service imply the defects inherent in the wage system, and can only partially remedy its inequities. A self-governing body of workers paid according to the piece-work system, and sharing profits or losses in a like ratio, constitutes the ideal of future industrial evolution. The practicability of such a system depends wholly on character: "The best industrial institutions are possible only with the

best men." Such an ideal adjustment can not become speedily prevalent; but a few successful efforts "might be the germs of a spreading organization. Admission to them would be the goal of working-class ambition. They would tend continually to absorb the superior, leaving outside the inferior to work as wage-earners; and the first would slowly grow at the expense of the last. Obviously, too, the growth would become increasingly rapid; since the master-and-workman type could not withstand competition with this co-operative type, so much more productive and costing so much less in superintendence."

For the present, Mr. Spencer sees the rhythmic principle exemplified in all evolutionary processes carrying us inevitably toward a *régime* of socialistic experimentation. Militantism is reviving in Europe and America. Equality is the ideal of the modern statesman, economist, and politician, rather than liberty. "There is small objection to coercion if all are equally coerced." This process can only be arrested by a great spread of co-operative production, which is not probable. Nations may perish, civilizations may decay, under this downward tendency. How long it will last and what will ultimately check it we can not now foresee. The processes of evolution will go on, however, gradually ultimating in that complete adaptation of human nature to the social state which is its ideal end and aim. This end will be proximated and preceded by a federation of nations whereby wars will be prevented and "the rebarbarization which is continually undoing civilization" will come to an end. Peace is the essential condition to that equilibrium between inner faculties and outer requirements, between man and society, which will constitute the final stage of human evolution. By a faith in eternal principles as constant and exalted as that of the religious saint, Mr. Spencer sees beyond the reversion implied in present downward tendencies the vision of man finally triumphant over false theories and the delusions of ignorance, at last completely fulfilling the demands of his higher nature in the organization of a society which may well be likened to the kingdom of heaven foretold by the founder of Christianity. May we not hope that the treaty of arbitration between Great Britain and the United States will constitute an initial step in the direction of this better day?

GENERAL NOTICES.

We have received a couple of attractively got up books, one on *Angling* and one on *Hunting*,* which are apparently the first two of a new series, to be called the "Out-of-door Library." The books are made up of short papers by different writers, all of which have appeared in Scribner's Magazine. The stories are for the most part accounts of trips to special regions famed for some particular game. The first chapter in Angling is a discourse on fly fishing. The Land of the Winanische is the account of a fishing trip to Lake St. John and its surroundings, where, it seems, the winanische or ouinaniche is localized. Nepigon River fishing, striped and black sea bass, and tarpon fishing in Florida are accounts of similar excursions. A chapter on American game fishes, and finally one on Izaak Walton, which describes his home and fishing grounds in Dovedale, complete the volume on angling. Hunting contains eight chapters. The first one, entitled Hunting American Big Game, is an account of the game conditions in Wyoming some fifteen or twenty years ago. Camping and Hunting in the Shoshone gives a general description of the Rocky Mountain scenery in this district, and describes exciting incidents from a number of hunting trips which the

* The Out-of-door Library. Angling, pp. 305, $1.50. Hunting, pp. 327, $1.50. New York: Charles Scribner's Sons.

author, W. S. Rainsford, has made to this region. A few pages are next given to climbing for white goats. Sport in an Untouched American Wilderness describes the region east of the State of Maine, between the Atlantic Ocean on the south and the Gulf of St. Lawrence on the north. A Kangaroo Hunt recounts several hunting excursions in the Australian bush. The Last of the Buffalo is a brief historical sketch of this now almost extinct animal, winding up with the description of a Montana buffalo hunt of the days when this game was still plentiful. At St. Mary's and Hunting Musk Ox with the Dog-Ribs complete the volume. Both books are well illustrated, and, while not particularly scientific or instructive, some of the descriptions are interesting simply as stories, and all of them will hold the attention of the sportsman.

Prof. *L. H. Bailey* has made a collection of his addresses to horticultural societies and similar essays, all bearing upon the process of evolution as observed in domestic plants.* Having had the plan for such a collection in mind for some time, he has been treating from time to time subjects which would together make up a somewhat systematic whole. He has grouped his papers as essays touching the fact and philosophy of evolution, those expounding the fact and causes of variation, and those tracing the evolution of particular types of plants. The last of these divisions is the most popular and practical, and therefore the most interesting to the horticulturist who is not a biologist. In one of these he discusses the question, Whence came the cultivated strawberry? or rather, Whence came the pine, its ancestor? Of the three possible origins—a hybrid, a direct development of the Chilian strawberry, or a modified form of our big wild strawberry—his examination leads him to decide on the second. In a similar manner he discusses the development of American plums, grapes, and carnations; of the petunia and the garden tomato. Much interesting horticultural history is used as evidence in these discussions. The opening essays of the volume are addressed more especially to the biologist. "It is only in the first two essays," he says, "that I have ventured to state any general convictions respecting the bolder problems of organic evolution; but I count these of much less merit than the statements of many plain and simple facts of observation and experiment which are made in the humbler essays. If the author has been fortunate enough to make any contribution to positive science in these pages, it is probably that associated with the vexed question of bud variation, which is chiefly presented in the third essay; but even this is novel only in its treatment." The first two essays deal with the survival of the unlike and the transmission of acquired characters. Prof. Bailey holds that unlikenesses are the greatest facts in the organic creation; that they survive because they are unlike, and thereby enter fields of least competition. He believes that acquired characters useful to the species tend to be perpetuated, and the more surely the longer the transforming environments are present. Intermediate in character as in position between the former and latter groups of essays are those dealing with the fact and with the causes of variation. In one of these he combats the idea that improvement in the quality of fruits is always at the expense of some other desirable quality of the plant. In others he discusses the distribution of cultivated varieties with reference to climatal and geographical conditions, the longevity of varieties, the relation of seed-bearing to cultivation, and similar topics.

Problems in Elementary Physics, by *E. Dana Pierce*, is the title of a little volume intended to be used as an auxiliary to the ordinary text-book or laboratory manual on physics. It consists of a series of selected problems for illustrating and also for testing the student's knowledge of the general physical laws. The introductory sections review the portions of arithmetic most needed in physical computations. A good working knowledge of algebra and plane geometry is assumed. A separate chapter is given to simple applications of the graphic method. (Holt, 60 cents.)

A seventh and revised edition of Dr. *Newell Martin's* useful handbook of physiology, *The Human Body*, has come to hand. A considerable amount of new matter has

* The Survival of the Unlike. By L. H. Bailey. New York: The Macmillan Co. Pp. 515, 12mo. Price $2.

been added, especially in connection with the physiology of the cardiac and general vascular nerves and of the brain. As Dr. Martin says, "Physiology has not finished its course," and while this volume contains all the more important facts at present known about the working of our bodies, it also makes it plain that very much is yet to be discovered. (Holt, $2.20.)

The first and most needed reform in methods of instruction called for in the educational revival begun by Horace Mann was the substitution of something better for text-book memorizing. Objects were chosen instead of words, and "things before words" became the motto. *James Johonnot's Principles and Practice of Teaching*, in the International Education Series, of which a new edition lies before us, was a potent factor in bringing about the above reform. He advocated the new education as based on the methods of Pestalozzi. The work of revision for the present volume has been done by Sarah Evans Johonnot. In a few instances the phraseology has been modernized, and a brief sketch of the pioneer work in manual training has been added, to show Mr. Johonnot's influence and close connection with the earliest experiments in this country. (Appletons, $1.50.)

The thirty-fourth annual *Report of the Michigan State Board of Agriculture*, as do all these reports, contains a large amount of interesting information, which is, however, as is also usually the case, so presented as to be rather difficult of access. There are nine hundred pages, and the topics range from the "management of swamps" to "climbing cutworms" and "five-banded bees." The volume contains a portrait and sketch of T. T. Lyon, Superintendent of the Michigan Experiment Station.

The *Transactions of the American Climatological Association* for 1896 have just reached us. Among the papers of special interest may be mentioned: Some of the Difficulties of Climato-therapy, by J. B. Walker; A Plea for Moderation in our Statements regarding the Contagiousness of Pulmonary Consumption, by V. Y. Bowditch; The Climate of Arizona, by M. A. Rodgers; The Sanitarium or Closed Treatment in Phthisis, by E. O. Otis; and A Study of Highly Mineralized Thermal Waters in the Treatment of Disease, by H. H. Schroeder. The object of the association is thus stated in its constitution: "The study of climatology and hydrology, and of diseases of the respiratory and circulatory organs."

General Principles of Zoölogy, by *R. Hertwig* (translated by George W. Field), comprises the first or general part of the author's *Lehrbuch der Zoologie*. When the latter volume first appeared there was no intention of a separate publication of the general part; but it is now thought that a book simply covering the "larger generalizations of the subject" will be of service and within the reach of many who would not purchase the larger work. The contents are well described by the title; it is a manual of zoölogy; there are paragraph headings in larger type, and the general arrangement of the text is such as to facilitate its use as a text-book, if desired. (Holt, $1.60.)

The *Elements of Physics*, of Profs. *Edward L. Nichols* and *William S. Franklin* (Macmillan, $1.50), has been prepared with a view to producing a text-book which shall correspond with the increasing strength of the mathematical teaching in university classes. While some text-books assume that the student's mathematical knowledge does not reach to the calculus, and others presume so much upon the mathematical training that they are unreadable for nearly all undergraduates, this one is intended for those who possess an elementary knowledge of the calculus. It is planned to be used in connection with illustrated lectures. It meets all difficulties, simplifying them as much as possible, but not evading them. The first volume, on mechanics and heat, has already been published. The present volume, the second, concerns electricity and magnetism, and a third volume is to follow.

The second title of Mr. *William Matthews's Nugæ Litterariæ* (or Literary Trifles) —Brief Essays on Literary, Social, and other Themes—well describes the character of the book. It is a collection, without special arrangement, of paragraphs and short essays on all kinds of subjects—ever bright and pungent and consequently interesting, always containing at least one good thought, often witty and more frequently suggestive, and

good to take up at any time of the day and to read steadily or in five to fifteen minute intervals. Six of the papers first appeared in the North American Review (Roberts Brothers, $1.50).

The second volume of *The Cambridge Natural History* (Macmillan, $3.50) contains a connected and comprehensive history of the flatworms and mesozoa, nemertines, threadworms and sagitta, rotifers, polychæt worms, earthworms and leeches, gephyrea and phoronis, and polyzoa. These various subdivisions are dealt with by special students and zoölogists. The chapters on polychæt worms, gephyrea and phoronis, and polyzoa are particularly acceptable as bringing together much information that has heretofore been locked up in special memoirs. In the chapter on rotifera, Prof. Hartog presents for the first time his views on the zoölogical affinities of the group. He says: "I have been induced to take a view of the structure of the rotifers that brings it into close relationship with the lower platyhelminthes and with the more primitive larva of the nemertines termed *pilidium*." He therefore changes the orientation of the rotifer, and places it, like the cuttlefish, mouth downward. For anterior and posterior he substitutes oral and apical; for dorsal and ventral he uses anterior and posterior. As in the volume on insecta, the name of the author of the first chapter only stands conspicuously on the cover. The volume and the whole series, in fact, is in a way so encyclopedic in its character that it seems as much out of place to have an author's name on the cover as it would be to see a single author's name on an encyclopædia. The volume is an indispensable adjunct to the library of a naturalist. The beautiful illustrations, the matter, well up to the latest researches on the subject, and the fact that specialists in each department have contributed to its material, bringing in their own original work, make the series unique and invaluable.

The United States Weather Bureau has issued a folio pamphlet on *Surface Currents of the Great Lakes*, deduced from the courses taken by floating bottles put into the waters of the lakes in 1892, 1893, and 1894. Of the five thousand bottles set afloat by the Bureau, six hundred and seventy-two had been recovered up to the preparation of this report. The text is accompanied by a chart of each lake, showing the courses taken by the bottles each season, and the movements of the waters which these courses indicate.

The *Report of the Commissioner of Education for the Year 1893–'94* makes two volumes of the familiar form containing over a thousand pages each. The usual statistics are accompanied by a large number of essays on educational topics. The reports of the "Committee of Fifteen" on training of teachers, on correlation of studies, and on city school systems, which have aroused widespread interest, are here printed; Rev. A. D. Mayo contributes a history of public schools during the colonial and revolutionary periods. A digest of school laws in the several States and of sanitary laws affecting schools occupies about three hundred pages. Other features are A Preliminary List of American Learned and Educational Societies, giving the officers, objects, and publications of each, and Some Recent Educational Bibliographies. There was an increase of over four hundred thousand pupils in the public schools of the country during the year, against an average of less than three hundred thousand for the preceding ten years.

A useful contribution to the current discussion of the money question is afforded in No. 74 of the Old South Leaflets, *Hamilton's Report on the Coinage*. All the important phases of the currency problem are discussed calmly and thoroughly in this masterly report of the first Secretary of the Treasury, and it is highly instructive to see how an able financier, unaffected by any of the prejudices of the present day, looked at matters that are now in hot dispute. The report makes a pamphlet of thirty-two pages. (Directors of the Old South Work, Boston, 5 cents a copy, $3 a hundred.)

Describing his book, *The Perfect Whole* (Ellis, $1.50), in its preface, *Horatio W. Dresser* says: "Thus, broadly defined, the purpose of this book is threefold—psychological, metaphysical, and practical. As a psychological analysis, it is especially concerned with the higher or spiritual nature of man. As a philosophical discussion, it aims to develop a generally sound view of reality by a consideration of materialism, agnosticism,

and mysticism in the light of their shortcomings when compared with the demands both of reason and the spiritual sense. It points out many important distinctions essential to a just view of life, and indicates the dangers of pantheism and of all one-sided conceptions of the universe. In its practical aspect it urges the same need of breadth and discrimination which it finds essential to a sound doctrine of reality. It is an urgent appeal to life, a plea for the realization of ethics and the application of spiritual law in every moment of existence." Mr. Dresser is also author of a book entitled The Power of Silence.

The fourth volume, completing the edition of *The Writings of Thomas Paine*, which *Moncure Daniel Conway* has collected and edited, is almost wholly devoted to Paine's religious writings. About half of it is occupied by The Age of Reason, to which we called attention when it was issued separately. This is followed by several essays arguing against the reality of divine inspiration in the Bible, and in support of a simple Deism and a pure morality. To appendixes are relegated a number of shorter writings—autobiographical, political, and technological—including a few pieces of verse and his will. In closing his labors on the history and the writings of Thomas Paine, whom he calls "the Great Commoner of mankind," Mr. Conway says: "Personally I place a very high value on Paine's writings in themselves, and not simply for their prophetic genius, their humane spirit, and their vigorous style. While his type of Deism is not to me satisfactory, his religious spirit at times attains sublime heights; and while his republican formulas are at times impaired by his eagerness to adapt them to existing conditions, I do not find any writer at all, not even the most modern, who has equally worked out a scheme for harmonizing the inevitable rule of the majority with individual freedom and rights." As to the historical value of Paine's political writings Mr. Conway adds, "He was literally the only man who came out with the whole truth, regardless of persons." (Putnams, $2.50 a volume.)

PUBLICATIONS RECEIVED.

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Anderson, Robert E. The Story of Extinct Civilizations of the East. New York: D. Appleton & Co. Pp. 213. 40 cents.

Bailey, Prof. L. H. Instructions for taking Phrenological Observations. Pp. 4.

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Penn, William. Plan for the Peace of Europe. (Old South Leaflets.) Boston. Pp. 20.

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Fragments of Science.

The Davy-Faraday Research Laboratory.—The Davy-Faraday Research Laboratory, established and equipped by Dr. Ludwig Mond, and presented by him to the British nation, was opened by the Prince of Wales, December 22d. From a review of the history of the idea of founding the institution, given by Dr. Mond in his presentation address, we learn that a movement was set on foot fifty years ago, under the auspices of Prince Albert, to establish an institute for the pursuit of pure chemistry, where practical and systematic instruction could be given to students, and a place provided where original research could be conducted by fully qualified investigators. At first it was proposed to attach this institute to the Royal Institution; but this plan had to be abandoned, on account of the inadequacy of the Royal Institution to provide accommodations for the scheme. The teaching part of the plan was, however, provided for a few years afterward by the foundation of the Royal College of Chemistry, which under the direction of Hofmann soon became one of the most successful institutions of that science in the world, while the provision of a place for original research still had to wait. Even before he knew of these facts, Dr. Mond had determined to found in London a laboratory of research in purely scientific chemistry and in physical chemistry—whence the greatest results in the knowledge of the real nature of things might be expected—and had be-

come convinced that such a laboratory would derive the greatest advantage if it could be associated with the Royal Institution. He had therefore improved an opportunity that offered to procure a suitable property immediately adjoining the Royal Institution and prepare it, in co-operation with suitable advisers, for its special work. As it stood, he believed that it would compare favorably with any other laboratory in or out of England, in the completeness of its appliances, and was unique of its kind, being the only public laboratory in the world solely devoted to research in pure science. The laboratory contains: On the basement, rooms for thermochemical, for pyrochemical research, and for electrical work, a battery of twenty-six accumulators, constant temperature vaults, and boiler rooms and storerooms; on the ground floor, rooms for research in organic and in inorganic chemistry, a fireproof room for experiments in sealed tubes, a balance room, and entrance hall and cloak room; on the first floor, the honorary secretary's room, a large double library connected with the library of the Royal Institution; on the second floor, a museum of apparatus; on the third floor, seven rooms for research in physical chemistry; on the fourth floor, rooms for organic and for inorganic preparations, a photographic room, and four rooms for research in physical chemistry; and on the roof an asphalted flat, with table, gas, and water. All the floors are connected by a hydraulic passenger lift. Dr. Mond has further furnished the laboratory with an endowment of £100,000, or $500,000—£38,000 sunk in the building and its equipment, and £62,000 for the endowment proper; and he has intrusted it to the Royal Institution, so as to insure its being open to men and women of all schools and of all views on scientific questions. Lord Rayleigh and Prof. Dewar have been appointed the present directors. The qualification for admittance to the privileges of the laboratory is to have already done original scientific work, or to be judged by the Laboratory Committee qualified to undertake original scientific research in pure or physical chemistry; but no person shall be excluded on account of nationality or sex. Admission to all the privileges is free, with responsibility for damage done.

Characteristics of Reformatory Prisoners.—The Twentieth Yearbook of the New York State Reformatory supplements the usual items of the formal report with some observations on the anthropometric characteristics of the inmates of the institution, which, while they are far from exhaustive, may cast considerable light upon the condition of the persons who find their way to such places. Exercise in the gymnasium was prescribed to the men of more marked physical defects, and general muscular increment in volume and power resulted from it. Comparing the five hundred and twenty-nine men of the reformatory with Amherst College students of nearly corresponding age, the reformatory man appears to be below the Amherst student's average ten pounds in weight, three inches and three tenths in height, fifty-six cubic inches in lung capacity, thirty pounds in strength of chest, thirty-two pounds in strength of back, and two dips in strength of arms, but reaches him in strength of legs. He is within one pound in weight and falls short an inch and seven tenths of the Wellesley College girl in height, and is only a little stronger than she in lung capacity and strength of chest, while he is superior in strength of back and legs. A large percentage of the heads are marked and scarred, as the result of street brawls and conflicts with the police, although the men's first explanation generally is a fall. Defects in the eyes are pretended in a large proportion of cases, but many of them are real. If near-sightedness, etc., are so much the result of civilization, school pressure, and close study as many physicians suppose, the class of men found in this institution should be practically exempt from it. "But the opposite are the exact conditions found." The physical make-up of the adolescent criminal appears to be reflected "as well in his visual organs as in other portions of his body, and the predisposition to eye trouble is inaugurated at both. The environment, personal habits, and mode of living only serve to act as exciting causes upon an already predisposed organism." Many of the prisoners in the reformatory are possessed of a defective inhibitory power or control, rendering it difficult and distasteful for them to apply themselves continuously to any one trade or

calling. As boys, they are truants or shirks; and later on they constitute the class of men never able to retain a situation for any length of time. Others become thieves, to be able to indulge their propensities for dissipation. Within the last few years there has been a marked increase in the number of those committed whose nervous and mental condition is unsatisfactory.

The Grass Garden of the Department of Agriculture.—In the grass garden of the United States Department of Agriculture double beds, or plats, are arranged on each side of the greater length for the growth of native plants to be allowed to come into flower. Inside of these bands is a narrow range of plats in which are grown various fodder plants—clovers, vetches, lupines, etc.—which do not belong to the grass family. Extending lengthwise through the center is a series of larger beds in which are cultivated those grasses that are known or supposed to be good formers of turf. An opportunity is afforded by such an arrangement for the comparison of one kind of grass or forage plant with another, and for noting their relative merits for special purposes. In it may be grown, too, for the use and information of the botanist, the grasses of all countries, arranged according to their natural tribes and subdivisions. Opportunities for study and experiment may thus be given the botanist and the economist such as can be got in no other way. Native plants should always have a prominent position here, in order that we may become familiar with them, and because they may exhibit under cultivation qualities of usefulness which can not be detected in them in their native stations. Mr. F. Lawson Scribner, Agrostologist of the United States Department of Agriculture, says, in the Yearbook of that department, that "we have better grasses and a greater variety of them native to our soil than we can ever get from Europe, and it will not be necessary to grow them ten or twenty years or more in order that they may be acclimated. . . . There are sixty native species of clovers found in the United States; there are more than sixty kinds of blue grass—distinct botanical species; there are twenty or more good grazing grasses related to the buffalo grass; there are fourscore or more of native lupines and twoscore vetches which have yet to be tried in our agriculture; and then there are broom grasses, and meadow grasses, and pasture grasses, and hay grasses, almost numberless, suitable to every kind of soil and rock formation and climate. And of all this wealth of kinds, the natural heritage of our country, hardly more than a dozen have been brought into cultivation."

Oral Schools for the Deaf and Dumb.—The first oral schools for the deaf and dumb were established in 1867, when the sign system of instruction had been in full sway for fifty years, and they had to dispute for progress with a method which seemed firmly established. In 1868, 38 out of the 304 deaf pupils in the New England States, or a little more than 12 per cent of the whole number, were taught in oral schools. The Horace Mann School was established in Boston the next year, and since then the percentage has steadily increased till, toward the end of 1893, 351 out of a total of 524 pupils, or 67 per cent, were found exclusively in oral schools. Outside of the New England States, besides the special schools in which it is exclusively used, the oral method has been admitted into many of the other schools, and both systems are taught in them—a fact which is expressed by the words "combined system." Statistics of the use of the oral method in the whole United States show very clearly that the oral method is extending with great rapinity. Prof. A. Graham Bell, in the address from which we quote these facts, adduces as an argument for the excellence of the oral system that the little schools in which it is taught, springing up by private enterprise, are able to compete successfully with the State sign schools until the latter introduce the oral system and become "combined" schools, while the little schools still live. In Germany the oral method has encroached upon the sign method till that has given way to a combined system. At the International Convention of Teachers of the Deaf, held in Milan in 1880, all the delegates from continental Europe voted for the preference of the pure oral method, while all the votes cast against the resolution were those of an Englishman and three Americans. This decision has been

accepted as final by all subsequent conventions. In 1881–'82, 81 per cent of the 280 schools for the deaf on the Continent of Europe were pure oral schools, 4 per cent were sign schools, and 15 per cent pursued a combined system. Prof. Bell traces the origin of his invention of the telephone to his observation of the ability of the pupils in the Horace Mann School to understand what was said to them by reading the movements of the lips. He was finally convinced of the fact, and was led to study the subject; then to devise machines and contrivances to help the children, the ultimate outcome of which was the telephone.

"Geological Myths."—As "geological myths," Prof. B. K. Emerson, in his chairman's address before the Geological Section of the American Association, characterized "the Chimæra, or the poetry of Petroleum; the Niobe, or the tragic side of calcareous tufa; Lot's wife, or the indirect religious effects of cliff erosion; and Noah's flood, or the possibilities of the cyclone and the earthquake wave working in harmony." Regarding a myth as meaning "a history, treasured and hallowed in the literary and religious archives of an ancient folk, of some startling or impressive event that, in the stimulating environment of poetry and personification, has completed a long evolution which disguises entirely its original," the author sought the origin of these stories in traits of the natural features with which they were associated. The Chimæra was described by the Greek poets as a monster having the tail of a dragon, the body of a goat, and the head of a lion, or the three heads of lion, goat, and serpent, vomiting fire and ravaging the mountains of Lycia. By comparing the references in various authors with the observations of Admiral Beaufort at the end of the last century, the examination of the spot by Spratt and Forbes in 1842, and the accounts of other modern travelers, the origin of the fable is traced to a mountain called the Yanar-dagh, formerly Chimæra (both names meaning burning mountain), from a crevice of which issues a stream of burning gas. The Greek word χαιμαίρα means goat. Hence the origin of the basis of the myth, the goat's body, to which, it really vomiting flames, imagination added the heads and the tail. Niobe, who wept herself into a stone over the death of her twelve children slain and petrified, is, as the American scholar Van Lennep has shown, a prehistoric statue of a woman, cut in the rock of Mount Sipylus, in Lydia, over which the water trickles from the rocks above. Below the figure lie in the talus rocks fallen from the cliffs, out of which imagination may construct the children turned to stone. The name Niobe is associated in sound with Greek words signifying the pouring of water and the falling of snow. Lot's wife is representative of a common phenomenon of the salt ridge of Kushum Usdum, or Sodom, on the Dead Sea, where one pillar is formed out of the mass as its predecessor is eaten away. The story of the Flood may well stand as a graphic description of the combined action of a cyclone and an earthquake with tidal wave, affecting the region of the Persian Gulf.

The Circulation in Plants.—The discussion in the Botanical Section of the British Association on the circulation of water in plants was participated in by Francis Darwin, Prof. Marshall Ward, Prof. Fitzgerald, and Dr. Joly, of Dublin. Mr. Darwin considered the path of the ascending current in trees and the force that produces the ascent of the water. Attention was called to the necessity of a complete study of the minute structure of wood in relation to the modern theories. Prof. Vines referred to an account he had published of a number of experiments on the suction force of branches. He had been under the impression that the results obtained were independent of the action of atmospheric pressure—that they were solely indications of tensile stress exerted by the transpiring branch upon the water in the apparatus; but now he had reason to believe that they were, as a matter of fact, affected by the atmospheric pressure. Hence these results are not different in kind from those of other observers, but are compatible with them. The observations brought out the two important facts that a high suction force can be developed by branches which have been deprived of their leaves, and that this suction force is not dependent on the life of the branch. Prof. Vines then proceeded to give an ac-

count of subsequent observations made with dead hazel branches (pea sticks), which had been found to develop considerable suction force, amounting in one case to nineteen inches and a half of mercury with a stick eighteen inches long. He concluded by expressing the opinion that in recent attempts to explain the mechanism of the transpiration current, the part played by the "imbibition" of the cell walls had been underestimated, and urged that what is especially requisite for a further advance is a more complete investigation of the properties of a dead stick.

Chinese Cheap Money.—The Chinese, as all the world may know, have cheap money, their standard of value being a copper coin about the size of a quarter of a dollar, with a square hole in the middle by which it may be strung, which is commonly called cash—in Chinese, *tsien*. They are strung by hundreds, with a knot to mark each hundred, and when large sums are to be used, strings enough to make out the amount are hung upon the shoulders of the carrier. Mr. Carles, a traveler in Korea, relates that he had to hire a special pony on one of his excursions to carry his cash, and that at one time he met two ponies carrying twenty-four thousand cash, or thirty dollars, to pay the workmen at a certain mine. The Chinese money-tellers become very expert in counting these cash and detecting false ones, for even these copper pieces, representing as little value as money can be made to do, are falsified. Emblems manufactured out of iron or of sand and gluten are often put upon the strings in place of the real bronze coin; in fact, a certain number of these spurious pieces are nearly always found. They are detected and separated from the genuine by boiling the pilé or string. The sand and gluten cash are dissolved, and the iron are exposed. The accountant weighs what is left; or, if the sum represents millions, he boils a few thousand and makes an average from the result which he applies to the whole.

The Smoke Nuisance.—A recent English inquiry into the smoke nuisance and the possibility of its abatement is noticed in Industries and Iron. The commission's report contains much interesting information, and sums up as follows: In presenting their report the committee express their conviction that in the great majority of cases the black smoke thrown into the air during the combustion of coal is preventable, either by hand or mechanical firing, and without great cost to the consumer. Often the prevention of smoke is accompanied with saving of expense, in that an increase of heat is developed by a more perfect combustion of the fuel; and where live fire bars are adopted—that is, where the bars have an automatic reciprocating motion — an inferior and cheaper quality of coal can be used, and thus a further saving of expense effected. The consumption of fuel was found to be lower in boilers fired by machine than in those fired by hand. In short, they say a manufacturing district may be free from manufacturing smoke—at least from the steam boilers, with which alone the committee have concerned themselves—and they give ample information as to the means by which it may be so freed. As the discharge of black smoke from factory chimneys was made a criminal offense in England by the Public Health Act of 1875, all that is necessary now to abate the nuisance is a call by public opinion for the application of the law.

The Earliest Animal Life.—The president of the Geological Section of the British Association, J. E. Marr, opened his presidential address, on stratigraphical geology, with a reference to the points in geological history of which we are ignorant. Specially prominent among these is that of the animal life of the earth during the vast length of time previous to the Cambrian period. The extraordinary complexity of the earliest known Cambrian fauna has long been a matter of surprise, and the recent discoveries in connection with the *Olenellus* fauna do not diminish the feeling. We may look forward with confidence to the discovery of many faunas older than those of which we now possess certain knowledge, but until these are discovered the paleontological record must be acknowledged to be in a remarkably incomplete condition. Valuable work has recently been done in proving the existence of important groups of stratified rocks deposited previously to the beds containing the earliest known Cambrian fossils. With our

present views, however, we can hardly suppose that organisms acquired hard parts at a very early period of their existence, and fauna after fauna may have occupied the globe and disappeared, leaving no trace of their having lived. In such case we are not likely ever to obtain from fossils definite knowledge of the character of the earliest faunas; and the biologist must not look to the geologist for direct information concerning the dawn of life upon the earth. The importance of detailed work may be inferred from a consideration of the great increase of our knowledge of the Permo-Carboniferous faunas as the result of recent labors in remote regions. It is specially desirable that the ancient faunas and floras of tropical regions should be more fully made known, as a study of these will probably throw considerable light upon the influence of climate on the geographical distribution of organisms in past times.

A Lobster's Motions.—The adult lobster, as appears from Dr. F. H. Herrick's study in the Bulletin of the United States Fish Commission, lives and feeds exclusively upon the sea bottom, which it never leaves of its own accord in any considerable degree. In traveling over the bottom in search of its prey, the lobster walks nimbly upon the tips of its slender legs. The large claws are extended in front of the head, a position which offers the least resistance to the water, while the two hinder pairs of walking legs, which end in hard, spurlike joints, serve as picks to steady the movements of the animal. In thus getting about, it has the constant aid of the delicate swimmerets, attached vertically to the under surface of the "tail," each of which consists of a short stalk and two very flexible blades. By the movements of the swimmerets the lobster is impelled slowly forward without the aid of the walking legs. The branches of the swimming feet are garnished with long, chitinous *setæ* or hairs, to which the eggs of the female are attached. When taken out of the water the lobster can only crawl in its vain attempts to walk, owing to the heavy body and claws, which the slender walking legs are unable to sustain. In exploring its feeding grounds, where an enemy is likely to be encountered, the legs which carry the long claws are extended forward in front of the head or carried somewhat obliquely, their tips resting on the bottom, and the long, sensitive "feelers" are waved constantly back and forth to give warning of any foe or other objects which the eye may fail to detect. These are exclusively organs of touch. If the anticipated enemy makes his appearance, or if the animal is surprised, as when it is suddenly touched with the blade of an oar or cornered, it will immediately strike an attitude of defense. It now raises itself on the tips of its walking legs, lifts its powerful claws over the head after the manner of a boxer, and strikes with one of its claws at the offending object, trying to crush it or tear it to pieces. By far the most powerful organ of locomotion in the lobster is the tail, by the flexion of which it can scull itself through the water with astonishing rapidity. The lobster, though less active and keen-witted than the higher crabs, can not be regarded as a sluggish animal in any sense. In the water its movements are graceful; it is wary, resourceful, pugnacious, capable of defending itself against enemies which are often larger than itself, and, if the occasion requires it, of running about with the greatest agility and speed. When a lobster is surprised it seems to disappear with a single leap or bound, as a locust or grasshopper might do. It never, however, rises more than a few inches or at least a few feet above the bottom, and it is evident that swimming at the surface would be impossible, on account of the great weight of the body.

Jack Rabbits.—The jack rabbits, which occur almost everywhere in the Great Plains and desert regions of the United States, are so called—also "jackass hares" and "jacks," "narrow-gauge mules," and "small mules"—from the resemblance of their large ears to those of the jackass. They may be seen abroad, Dr. T. S. Palmer says in his account of them, at almost any hour of the day. Living as they do on the open plain, where they are compelled to rely for safety on quickness of hearing and on speed, their ears and hind legs are developed to an extraordinary degree. This gives them a somewhat grotesque appearance, but in reality few animals are more graceful than they as

they bound along when once thoroughly alarmed. A closer acquaintance with their habits will reveal many points of interest, and will arouse admiration for the way in which they seem to overcome every adverse condition of life. Unlike the cotton-tails or the common rabbit of Europe, these hares do not live in burrows, but make "forms" under bushes or in patches of weeds, where they find protection from the weather and bring forth their young. Where there are no bushes they seek the protection of any object that can shield them from the sun—even the shadows of the telegraph poles along the railroads. Extremes of climate do not appear to affect them. They feed on the bark and leaves of shrubs and on herbage. They live on the grasses of the plains, the bark of willows, greasewood, cactus, shrubs which other animals seldom touch. Sometimes it is hard to see where they can get food enough; but lack of water and of green herbage serves only to reduce their numbers, and rarely causes their complete absence from any region. Among the greasewood on the alkali flat northwest of Great Salt Lake and on the cactus-covered deserts of Arizona the jack rabbits are almost as fat and sleek as when feeding in the alfalfa patches and vineyards of southern California. If necessary, they can travel long distances for food; but, as they seldom drink, scarcity of water causes them little inconvenience, and the juicy cactus pads or ordinary desert herbage furnish all the moisture necessary to slake their thirst. They are very destructive to gardens and orchards, and, as they multiply rapidly, they often become great pests, and would be in danger of overrunning the country if not kept down. Where new land is cultivated or irrigated they seem to swarm in from the surrounding country, and flourish where civilized conditions prevail. The damage done by them in Tulare County, California, in a single year has been estimated at six hundred thousand dollars, and a single county in Idaho has spent more than thirty thousand dollars in bounties on them. Fortunately, they can be used for coursing, for their skins, and for food. As they outrun all but the swiftest hounds, coursing for them is rare sport. The consumption of them for food amounts to about six hundred thousand a year, and is gradually increasing. Under the energetic measures that have been taken against them their numbers are gradually diminishing.

Women in Business.—A London trades paper has extracted from an official report on bankruptcy the fact that comparatively few failures occur among women engaged in business. This, says the Spectator, remarking upon the subject, we would expect to be told; "and in this case, at any rate, the statistics correspond with the general impression of the world, that women in business are more careful than men—less liable to run into excess and to ruin themselves by too adventurous a spirit." Another fact parallel with this, but which has not found its way into the statistical reports, may be accepted as generally if not universally true, that women in business do not accumulate large fortunes. It follows, from the same reason, that enterprises that bring great returns also almost necessarily involve great risks; and avoidance of the risk carries with it avoidance of the accompanying chance of making a fortune. "To put the matter in a nutshell, a woman conducts her business on the cardinal principle of making as few losses as possible; a man, on the cardinal principle of making as many profits as possible."

W. F. Ainsworth.—W. F. Ainsworth, who died in London, November 27th, in his ninetieth year, was a veteran in science, the recollection of whom may have passed from the minds of most of the present generation. He took a surgeon's degree at Edinburgh in 1827, and, having gone to the School of Mines in Paris, made a vacation walking tour in the Pyrenees and volcanic districts of Auvergne. He afterward started and conducted the Edinburgh Journal of Natural and Geographical Science; walked to London in a geological study of the country, and became a member of the Royal Geographical Society. In 1831 he made a study of the cholera, was appointed surgeon to a cholera hospital in London, and was sent, when the disease broke out in Ireland, to the affected towns and districts. Results of these experiences and attendant adventures were many papers published on cholera, and a monograph, in 1834, on the Caves of Bally-

bunnion, which is described as "a remarkable production in respect of its date and the subsequent development of geology." In 1833 he was appointed surgeon and geologist to the Euphrates Expedition under Chesney; and, after returning from this was placed in charge of another expedition, sent out by the Royal Geographical and the Propagation of Christian Knowledge Societies, to the Christians in Chaldea. Two books made known the scientific and other observations he made in these expeditions, to be followed, in 1844, by a geographical and descriptive account of the expedition of Cyrus and the retreat of the Ten Thousand with which Xenophon made the world acquainted. He returned to England in 1841; conducted the Syro-Egyptian Society; labored for the adoption of the route to India *via* the Euphrates and Tigris Valleys; was founder and honorary treasurer of the West London Hospital; and published new geographical books. A bibliography of his contributions to knowledge, the Athenæum says, "would itself fill a volume." He was a corresponding member of the Geographical Society of Paris, the German Oriental Society, and the Moldavian Natural History Society.

MINOR PARAGRAPHS.

General Francis A. Walker, President of the Massachusetts Institute of Technology, died very suddenly of apoplexy, January 5th. He was a man of great versatility, filled many important public positions, and contributed much to knowledge through the results of his economical studies. He was born in 1840; was graduated from Amherst College in 1860; adopted the profession of law; went into the war and rose to be a brigadier-general; after the war began to teach; did editorial work on the Springfield Republican; was appointed chief of the National Bureau of Statistics in 1869. As superintendent of the ninth and tenth censuses he made great improvements in methods. From 1873 to 1881 he was Professor of Political Economy and History in the Sheffield Scientific School, while he also lectured at Johns Hopkins and Harvard Universities. In 1881 he became President of the Massachusetts Institute of Technology. He was also chief of the Bureau of Awards at the Centennial Exhibition; a United States Commissioner to the International Monetary Conference at Paris in 1878; President of the American Statistical Association in 1882; and President of the American Economic Association in 1886. He was author of a large number of books and papers, chiefly on economical subjects, which are much consulted.

The Tsimpshian Indians, living around Port Simpson, British Columbia, were described by Prof. B. Adler in the British Association as being the most intelligent, progressive, and best-built natives he had seen in any country. Of the various customs of these and the other tribes of the region, the author described the potlatch as a solemn ceremony whereby on a chieftain's death his successor, who curiously is the late chief's eldest sister's eldest son, is invested with the chieftaincy in the presence of the whole tribe, taking the late chief's flute as a sacred symbol of office. The Indians were represented as having a marvelous adaptability to song, eloquent speaking, and building. The Tsimpshians were the most wonderful linguists the author had ever met, and their facility for acquiring other languages than their own was almost an instinct. Their own language is very complete, well inflected, and aided by auxiliaries.

The Royal Society medals for 1896 were distributed as follows: The Copley medal to Carl Gegenbauer, Professor of Anatomy in Heidelberg, in recognition of his pre-eminence in the science of comparative anatomy or animal morphology; the Royal medals, one to Sir Archibald Geikie as the most distinguished British geologist, the other to Prof. C. V. Boys, who has given to physical research a method of measuring minute forces far exceeding in exactness any hitherto used; the Rumford medal to Prof. Philipp Leonard and Prof. W. C. Röntgen; the Davy medal to Prof. Henri Moissan; and the Darwin medal to Prof. Giovanni Battista Grassi.

The first indications of gold in Nova Scotia were observed, according to Sir James Grant's paper in the British Association, in

1860, and new discoveries were made in 1862, giving additional stimulus to the industry. In 1865, by the utilization of appliances for removing gold from low grades of ore, the mines became extremely lucrative. The average yield per ton for thirty-three years was thirteen dollars, and it was estimated in 1895 that Nova Scotia had produced gold to the value of $11,500,000. In the province of Quebec, gold was first discovered in 1847. Prof. Hardman made an examination in that province in 1895, when, after running a tunnel six hundred feet long, he struck the bed of an old river, and in three weeks removed enough gold to pay the entire expense of his operations. There was, consequently, feverish excitement in the province.

NOTES.

Mr. W. Baxter, Jr., writing in Cassier's Magazine, gives the total amount of capital invested in electric lighting in the United States as $500,000,000, and the number of plants, public and private, as more than 10,000. About 500,000 motors are in use, and they are valued at $100,000,000. The electrical apparatus used in mining is estimated to be worth $100,000,000. The value of the electric elevator industry is supposed to be about $15,000,000. The electric railways are believed to represent a capital of more than $700,000,000, and the aggregate of capital invested in electric railways and lighting, exclusive of the value of the establishments that manufacture the machinery and apparatus, is about $1,500,000,000.

A new railway between the Russian Asiatic towns of Nertchinsk and Vladivostock, crossing Manchuria to unite the two branches of the Trans-Siberian Railway, is to be constructed with French capital and by French engineers, under the control and with the guarantee of the Russian Government—to be, nevertheless, a Chinese line, administered by Chinese.

A Swiss society of popular traditions has been formed at Zurich for the collection of anthropological and ethnological notes relative to the several cantons, documents on the manners, dwellings, costumes, festivals, working tools, musical instruments, industrial arts, family celebrations, religious solemnities, weather lore, popular literature, games, names of places and persons, and other items in folklore. A special review will be published, to embody the results of the inquiries made under the society's auspices.

Mr. H. Harries has shown, in the Royal Meteorological Society, that hail and thunderstorms are not, as has been supposed, extremely rare in the arctic regions. He has examined one hundred logs of vessels which have visited those quarters, and seventy-five of them gave records of hail having been encountered at some time or other. Thunderstorms were not so frequently mentioned as hail, but they were observed in seven months out of the twelve, most frequently in August.

Leo Brenner, of the Manora Observatory, Istria, has acknowledged a gift of $1,650 from Miss Catherine W. Bruce, of New York, for the use of the observatory and additions to its equipment. Herr Brenner is engaged in the study of Mars, and reports the discovery of several interesting features, including twenty new canals, "very broad, and consequently probably double," and a new "oasis" or "lake."

An American locomotive works is in course of erection at Nijni Novgorod, Russia, to have capacity for turning out one hundred and fifty locomotives a year, and employ about one thousand men.

Proof regarded by him as abundantly satisfactory has been collected by Mr. N. T. Bonner, of Cincinnati, from study of Pompeiian boilers, that the principle of the water-tube boiler was fully understood and appreciated by the people of Pompeii two thousand years ago. The Pompeiian boilers, being used principally for heating water and wine, the shells and covers were only such as would offer a slight resistance to the escape of the steam.

Formalin, a solution of formic aldehyde, has been recommended to the London Entomological Society as a preventive of mold. An object once sprayed with it never becomes moldy afterward. It is much used in the color industry, and is therefore produced on a large scale.

Besides the common early belief in spirits of the forest, sea, and mountain usually needing propitiation, Mr. Henry Ling Roth finds among the natives of Sarawak and British North Borneo a conception of a well-disposed beneficent *Petara*. A system of omens exists for the regulation of life, and with it is combined a sort of worship of the birds with whose movements the omens are associated. The medicine men or medicine women pretend to extract disease in the form of bits of stick or stones, and rags are hung on bushes by the roadside to turn away or carry off disease. Cairns are built up by passers-by, each adding a stone, and *tabu* prevails, as in the Pacific Islands.

Messrs. Petermann and Graftian, of the Belgian Academy of Sciences, find that hoarfrost is peculiarly rich in nitrogenous compounds, and therefore plays an important part in increasing nitrogenous matter in the forest and in purifying the air.